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NOAA AUTHORIZATION

HEARING

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE
AND TRANSPORTATION
UNITED STATES SENATE

NINETY-NINTH CONGRESS

SECOND SESSION

ON

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
AUTHORIZATION

APRIL 15, 1986

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CONTENTS

LIST OF WITNESSES

Page

Opening statement by Senator Gorton 1
Opening statement by Senator Hollings 3
Calio, Hon. Anthony J., Administrator, NOAA; accompanied by Dr. William P. Bishop, Acting Assistant Administrator for Environmental, Satellite, Data, and Information Services; Dr. Richard E. Hallgren, Assistant Administrator for Weather Services; Alan R. Thomas, Deputy Assistant Administrator, Office of Oceanic and Atmospheric Research; and Kathleen Charles, Deputy Director, Budget and Finance Office 3
  Prepared statement 16
  Questions of Senator Hollings and the answers 19
Frank, Dr. Neil L., Director, National Hurricane Center 23
  Prepared statement 30
Ramsay, Col. Allan C., Chairman, Joint Environmental Satellite Coordinating Group, Office of the Under Secretary of Defense for Research and Engineering 32
  Prepared statement 36
VonderHaar, Dr. Thomas, professor of atmospheric science, Colorado State University; and Samuel W. McCandless, Jr., president, User Systems Inc., on behalf of National Ocean Industries Assn 44
  Prepared statements:
    Dr. VonderHaar 48
    Mr. McCandless 53
Williams, C. P., president, Earth Observation Satellite Co 38
  Prepared statement 43

ADDITIONAL ARTICLES, LETTERS, AND STATEMENTS

Changnon, Stanley, principal scientist, Illinois State Water Survey; R. Lynn Rose, director, North Dakota Weather Modification Program; Paul Summers, assistant director, Utah Division of Water Resources; Joseph Warburton, executive director, Atmospheric Sciences Center, Desert Research Institute, Reno, NV, statement 62

NOAA AUTHORIZATION

TUESDAY, APRIL 15, 1986

U.S. SENATE
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:37 a.m. in Room SR-253, Russell Senate Office Building, Hon. Slade Gorton [chairman of the subcommittee] presiding.

Staff members assigned to this hearing: Charlie Faust, professional staff member and James Drewry, minority staff counsel.

OPENING STATEMENT BY SENATOR GORTON

Senator GORTON. Good morning and welcome to this hearing of the Senate Commerce Committee's Subcommittee on Science, Technology, and Space. We are here to discuss fiscal year 1987 funding for the satellite and atmospheric programs of the National Oceanic and Atmospheric Administration.

NOAA is responsible for the operation of three satellite systems: the geostationary, or GOES; environmental satellite system, polar orbiting environmental satellite system; and the land remote sensing satellite, or LANDSAT.

NOAA's atmospheric programs include the observation, forecast preparation and dissemination activities of the National Weather Service, as well as atmospheric and hydrological research programs. These research programs make up approximately 60 percent of NOAA's budget.

The administration has sent to the Congress a budget which proposes a net reduction of $95 million in these programs for the fiscal year 1986 appropriated level. The committee is concerned about the potential effects on NOAA's ability to provide timely and accurate weather information. Our concern is focused not just on the next fiscal year's budget, but on the long term strength of NOAA's programs.

Once again, the Administration is proposing to eliminate one of NOAA's two polar orbiting satellites. The Congress has rejected this proposal for several consecutive years, but our need to reduce the Federal deficit causes us to re-examine the need for two polar orbiters.

This morning we will discuss the effect of this proposal on NOAA's weather forecasting and search and rescue responsibilities, and we will examine the potential savings associated with eliminating a polar orbiter. NOAA's budget indicates a net saving of $59 million in 1987 from this proposal, but one NOAA study stated that necessary changes in management of the system would effectively eliminate those savings.

We also will compare NOAA's polar orbiting satellite system to the Defense Meteorological Satellite Program. The committee hopes to learn which elements of the systems can be combined, to examine the feasibility of complete convergence of the systems.

Another proposal of concern to the committee is the termination of Federal subsidization of the Earth Observation Satellite Company's commercial LANDSAT venture. The committee developed the legislation that would set guidelines for the LANDSAT commercialization and last year authorized $295 million through fiscal year 1989 to support EOSAT's development of a follow-on to the current LANDSAT system.

We are concerned that the Administration apparently wishes to end U.S. involvement in land remote sensing and leave the market for data products to foreign systems, notably the French SPOT system, which was launched earlier this year.

The committee is aware that the Department of Commerce has proposed to preserve the polar orbiting and LANDSAT systems by combining the two missions on a common platform. We understand that this proposal is not yet Administration policy, but we believe that the proposal must be addressed in the fiscal year 1987 budget cycle and we look forward to learning more about the technical and budgetary features of the proposal.

The major funding issue in the atmospheric program area concerns development of the next generation weather radar, or NEXRAD system. NEXRAD is being developed by NOAA, the Federal Aviation Administration, and the Air Force, to modernize our Federal weather radar capability.

The Administration has proposed to fund NOAA's share of NEXRAD procurement out of the FAA's aviation trust fund. The committee has a number of questions about this proposal and about the status of NEXRAD development in relation to an established schedule which calls for production of NEXRAD units to begin in 1987.

The Administration has requested funding increases for advanced data processing and automated observation systems, in an effort to modernize the operations of the National Weather Service. This morning we will discuss the status of Weather Service modernization and NOAA's plans to reorganize the structure of the Weather Service over the next decade.

We will also hear today about NOAA's hurricane forecasting and monitoring services. Last year was a particularly busy one for NOAA's National Hurricane Center, and we look forward to discussing the status and future of NOAA's hurricane programs.

Senator Hollings has a statement that I will include in the record.
[The statement follows:]

OPENING STATEMENT BY SENATOR HOLLINGS

Mr. Chairman, I am glad we are holding this hearing on the NOAA atmospheric and satellite programs. Although the Congress has succeeded in restoring many of the past proposed reductions in NOAA's budget, 5 years of inflation have eaten into agency funding, and each passing year presents us with a more painful set of alternatives. Even the most optimistic view of the FY 1987 funding picture presents a series of unpalatable choices. The LANDSAT contract subsidies, second polar orbiter, and National Weather Service modernization are all at risk. This hearing will give us a chance to understand the ramifications of the funding choices pertaining to these programs.

Before closing, I note that Dr. Neil Frank of the National Hurricane Center will be testifying. We have seen Dr. Frank on television with considerable frequency in the past several years, especially throughout the lengthy and busy hurricane season that just concluded a few months ago. Speaking for the citizens of the Southeastern United States, I can say we owed him a great debt of gratitude for helping coastal communities prepare for hurricanes. I look forward to the insights that Dr. Frank and the other distinguished witnesses will offer for this hearing.

Senator GORTON. This morning we will welcome witnesses from NOAA, the Department of Defense, and several interested organizations outside of the Federal Government. We look forward to hearing their statements and will be happy to include in our record witness statements from any other interested parties.

We begin, of course, with Dr. Tony Calio, the Administrator of NOAA, who as always is most welcome to this committee.

STATEMENT OF HON. ANTHONY J. CALIO, ADMINISTRATOR, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, DEPARTMENT OF COMMERCE; ACCOMPANIED BY DR. WILLIAM P. BISHOP, ACTING ASSISTANT ADMINISTRATOR FOR ENVIRONMENTAL, SATELLITE, DATA, AND INFORMATION SERVICES; DR. RICHARD E. HALLGREN, ASSISTANT ADMINISTRATOR FOR WEATHER SERVICES; ALAN R. THOMAS, DEPUTY ASSISTANT ADMINISTRATOR, OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH; AND KATHLEEN CHARLES, DEPUTY DIRECTOR, BUDGET AND FINANCE OFFICE

Dr. CALIO. Thank you, Mr. Chairman. It is a pleasure for me to be here to represent the Department of Commerce to present the National Oceanic and Atmospheric Administration 1987 budget review in the areas of science and technology.

I have with me this morning: Dr. Richard Hallgren, the head of the National Weather Service; Kathleen Charles, the Deputy Director of our Budget and Finance Office; and Dr. Bill Bishop, the head of our Satellite Service; to be able to assist me.

If I may, Mr. Chairman, I would like to submit by written statement for the record and try to summarize.

Senator GORTON. It will be included in the record in full.

Dr. CALIO. Thank you.

Let me start with the Weather Service and our attempts to modernize the Weather Service and using the advanced technology. You mentioned in your opening statement the importance of the Doppler radar, NEXRAD. I am happy to report, through the efforts of the Weather Service and the work with the contractors, that we are proceeding towards the validation tests of the NEXRAD prototypes this summer. We expect to have that effort completed this summer and the decision to proceed with a pre-production buy of ten units in the late fiscal year 1986, early fiscal year 1987 time frame.

That program is on the revised schedule that we established last year for the 1986 program. We do have the participation, the active participation of DOD and FAA. And as you commented, we are requesting in the fiscal year 1987 that the $47 million for the National Weather Service portion of the NEXRAD development be taken from the Airport and Airway Improvement Act, or the trust fund.

That was presented by OMB to the FAA, and to my knowledge there has not been any disagreement with that as far as the FAA is concerned. So we are proceeding along that line with the NEXRAD program.

The next component associated with the modernization of the Weather Service is the automated surface observation system. We are on schedule to deploy or proceeding to deploy that system in the 1989 to the 1992 time frame.

During 1987 we will add the results of the 1985-1986 Kansas sensor demonstration project, begin design, fabrication, and testing of the production models and continued production of laser ceilometers. So ASOS is also proceeding very well.

The third area, the advanced weather interactive processing system, is pretty close to schedule. We're about a month or so within the schedule that we had put forward last year. We intend in 1987 to go out on the competitive design work, to be contracted in late fiscal year 1986, look at the advanced communication architecture that's needed to support the exchange and distribution of data and data products, and do risk analysis and testing of prototype system elements.

So the necessary work to proceed with AWIPS is moving along reasonably well. Along with that, Dr. Hallgren and I will be starting this year to look at the restructuring of the National Weather Service in line with the deployment of these new technologies, and we intend to have these studies completed towards the end of this fiscal year, so that by the time we submit our fiscal year 1988 budget we should be able to submit to you a plan of the restructuring of the Weather Service.

We are currently putting a team together to look at how we should carry out that task, and anticipate that it will take us about three to four months working internally before we prepared our materials for the Department and for OMB and for Administration review and approval.

Let me move, if I may, from the Weather Service on to the satellite service. We were very pleased to be able to have the approval of the Congress to go on with the acquisition of five geostationary environmental satellites. As you know, we signed a contract for those five satellites at the end of last calendar year and are able to anticipate, with the signing of that contract with the five satellites, a $5 million reduction.

And we look at, over the lifetime of the program, because of that block buy a savings to the Federal Government of about $100 million.

As we see it, the geostationary satellite system will become fairly stable once those satellites are built, are in production. We plan to be able to launch the next geostationary satellite in May of this year, hopefully alleviating the problem then that exists where we have just a single geostationary satellite coverage that we have today. At that point then we'll have again East and West Coast coverage.

The satellite being developed right behind it will be launched later in the year, so we'll have a hot spare capability. And our notion in being able to do that is again to be able to save further costs, because we would not have to pay for maintaining the launch operations that are associated with the launching of that second geostationary satellite.

So I am very pleased with the progress that we have been making in the geostationary satellite arena.

In the polar orbiting arena for satellites, life is not as tranquil and peaceful. As far as the polar orbiting environmental satellites are concerned, we plan to launch NOAA-G in June of this year, and after NOAA-G then we are proposing that we proceed towards a one satellite system. We believe that the risk that one takes with respect to a one satellite system compared to the cost savings that we can realize is a reasonable risk to take.

I know there are different views with respect to that risk, but we are looking at a $57 million potential saving in fiscal year 1987 and $115 million during the lifetime of that program.

If I look at some of the statistics over the past 15 years, of the 13 satellites that were launched, 11 of them got into orbit, and I think of those 11 there was what, one that lived a lifetime of less than 18 months. So that the design concept that we are proceeding with with a single polar orbiter satellite from my perspective seems to be a reasonable one to take in light of our interest to reduce Federal expenditures.

So we are proceeding to propose to you that we reconsider this notion of a one polar orbiting satellite.

We have not proceeded with the procurement of the next series of satellites, which is the NOAA-KLM. The first of those is not necessary under the one polar orbiter regime until year 1991. We would be proposing to come forward with the next major funding increment in next year under that flight schedule.

It would allow us also during the next few months to resolve two issues. One, if the proposal that you suggested in the Omnistar is not accepted, we will be able to proceed with the buy of the KLM polar orbiting satellites immediately and hopefully, meanwhile we will have our launch vehicle situation straighened out.

And I think you are aware that over the past year we have had some discussion as to whether those satellites should either be launched by Titan class expendible launch vehicle or the space shuttle. I think that can be resolved between now and the time we prepare and submit our fiscal year 1988 budget.

In the land remote sensing area, as you know, we signed the EOSAT contract last October. And in the fall of last calendar year, EOSAT submitted to us a conceptual change for the--excuse me—an engineering change concept, that would modify the design of the satellite for the LANDSAT 6 and 7.

They are recommending a change from the TIROS class satellite to a shuttle service orbiting platform, which would have a lifetime of approximately 15 years. As a result of that concept and the proposal that EOSAT submitted to us, we put together an engineering team made up of outside engineers and NASA engineers and our own. We put together a management team.

We evaluated the risks and the costs associated with that new concept. We felt those risks were very reasonable compared to the existing concept of the TIROS N class satellite, and so on March 18th, I believe it was, we signed an engineering change order to accept the Omnistar proposal for EOSAT and the LANDSAT platform.

During that period of time, it became very apparent as far as the Administration was concerned that we can no longer afford to subsidize these kinds of ventures, that if they are to exist they must exist on their own merit. As a result of that, we have worked with EOSAT in preparing a proposal to combine both the polar orbiting environmental satellites and the land satellites on this Omnistar platform. We wouldn't have had the opportunity had EOSAT not come forward on their own with a concept like Omnistar.

We have reviewed that proposal. It is currently also being reviewed by the Administration, and I hope within the next few weeks, being sensitive to the need to discuss it during this fiscal year 1987 budget hearings, we will be able to have a decision on the part of the Administration as to whether we will move forward with that proposal or whether we will stay with the existing program that was submitted in the present fiscal year 1987 budget request.

If I may, I would like to move on to the research and development area. In fiscal year 1987, we have reduced the atmospheric research and development from $81 million appropriated in fiscal year 1986 to a presidential request of $75 million in fiscal year 1987, and we have made a few minor shifts within the atmospheric research program.

We still feel we are currently carrying out the recommendations of the National Academy of Sciences in the three major elements of their recommendation, namely that we should pursue mesoscale research, atmospheric chemistry, and the inter-annual climate studies, and we are indeed doing that.

The $6 million reduction is really a set, a series of initiatives, plus some decreases that we're recommending, requesting in our fiscal year 1987 budget. We are asking for an increase in the radiatively important trace species in atmospheric chemistry of about a million dollars.

We want to enhance our capability to be able to forecast the onset of hurricanes. You will hear more about that from the experts later on this morning. Essentially what we are doing is asking for a million dollar increase in hurricane research.

And we want to be able to expand our profiler, which is essentially a Doppler radar that provides wind soundings. Right now, we are currently purchasing 30 of those to take place in a demonstration project in the central part of the United States in the next year or two.

We want to be able to also measure the thermodynamic profiles in the atmosphere, and so we have tried to enhance that program of research in fiscal year 1987.

Some of the offsets that we have provided there: There is essentially a $2 million reduction in PROFS. That, as you know, is the test bed where we have developed the necessary software to be able to give us the design requirements for AWIPS 90. We feel we have sufficient funds to operate PROFS and we can use that facility to support other software development, like FAA and the use of their terminal Doppler systems and their central weather processor development.

We have reduced mesoscale research about $2.2 million, leaving $4.7 million in that area, and we feel that that is sufficient funding for fiscal year 1987.

And finally, in the area of atmospheric climate research, we have reduced the TOGA program about a million dollars, leaving about $2.5 million in the tropical ocean global atmosphere program. We feel that that is an adequate base to allow us to work with other countries and see if we can gain their support in providing observation vessels, scientists, instrumentation, to be able to make measurements in the tropical region around the world.

This summer—excuse me. The beginning of this year, we were very successful in bringing the People's Republic of China into the program. They have committed to make eight separate cruises during the next 4 years is support of the TOGA program, which would translate into a contribution of about 5 to 6 to $7 million to match with U.S. funds.

We are currently talking to Japan, Australia, and some other countries to see if we can expand the program as we participate in the world climate research activities.

That pretty much summarized the major efforts, the major thrusts associated with the program, and I am prepared to answer any questions you may have.

Senator GORTON. You mentioned in your brief and general comments on Omnistar that you are not prepared to make specific recommendations now. You have removed some $150 million from the budget for a second polar orbiter and for the EOSAT contract as it was originally signed.

If I understood you correctly, when we were speaking of this question you said you would soon come up with recommendations as to whether or not to go ahead with Omnistar or to stick with the President's budget.

Dr. CALIO. That is correct, sir.

Senator GORTON. The alternatives before the committee, of course, are greater in number than those two. We could determine, if you wished to recommend it or if you did not, to go ahead with Omnistar and stick with the President's budget, or to stick with the plans we voted for last year. That would cost us close to $150 million.

As a consequence, Dr. Calio, I cannot emphasize too strongly the high desirability of having the Administration's proposals with respect to Omnistar as promptly as possible. I am not at all certain that the committee is willing to seriously consider the President's budget as proposed, which would seem to us to be a considerable backing away from not only commitments which have been made in the past, but what the committee perceives to be appropriate policy. The Omnistar proposal, of course, to the extent that we know anything about it, is a very interesting one.

If you can add anything to what you have said this morning or respond to us as to how soon you think you will have recommendations all the way through the Administration, we would appreciate it.

Dr. CALIO. I really cannot, Mr. Chairman, give you a time frame. We are all working quite diligently to try to review the positive and negative aspects of that proposal. I prefer not to give you a date. We are working diligently to try to get some sort of a resolution one way on the other.

Senator GORTON. And we simply want you on notice and OMB and the Administration on notice that at a given time not too far in the future we are going to make our decision, whether we have got your recommendations or not.

Dr. CALIO. I understand, sir.

Senator GORTON. Would all the instruments that the polar orbiters currently carry, together with the advanced microwave sounding unit, be carried on Omnistar if that proposal were to go forward?

Dr. CALIO. You are going to get me into a discussion about what is on board and what is not. The current proposal does not carry on one of the platforms all of the instruments that are currently on both polar orbiting METSAT's. We are in the process of reviewing that right now.

That is one of the issues we are looking at, as to how can we further contain costs—the main instruments are on both, but some of what I might call the ancillary instruments, and others are not on both satellites.

Senator GORTON. What you are saying is there is no absolutely firm decision at this point as to which would be on and which would be off?

Dr. CALIO. We have made a proposal, and there is some flexibility in that proposal, depending on the costs, who would pay for it, and the like.

Senator GORTON. Now, has the Department of Commerce and EOSAT agreed that the use of Omnistar as you have proposed it would meet the requirements of the LANDSAT contract?

Dr. CALIO. To the best of our ability to evaluate what we have on the table right now, I think the answer to that is yes. We really have to take it further. If the proposal is accepted by the Administration and by the Congress, then we have to work out a much more detailed negotiation between the Department of Commerce and EOSAT, and at that point my feeling is we will satisfy the letter of the law. But we do not have all the pieces tucked in yet.

Senator GORTON. The recent tragedy to the Challenger has caused a great delay in the space shuttle program. We are all concerned that civilian agencies may have difficulty in arranging timely shuttle launches, even when it is presumed by reason of the delays that the Department of Defense has priority.

Has NOAA addressed this concern, and if so how?

Dr. CALIO. The Department of Commerce has a member on the inter-agency task force on space where these manifests are being considered. These, working off the backlog and the plan of action, are being considered.

Our people, myself and Dr. Bishop, have interacted with the Department of Commerce representatives and our interests have been forward to that inter-agency working group.

Senator GORTON. Are you satisfied with the way in which they have been handled at this point?

Dr. CALIO. I am satisfied with the way it has been handled. We do not know how the problem is going to be resolved yet, mainly because we do not know what the recovery plan is going to look like. And until that recovery plan firms up, I do not think we can be comfortable on how we are going to be able to proceed in the future.

I am not overly concerned. I think that the interests of NOAA and the environmental satellite service will be taken into consideration and resolved.

Senator GORTON. What is your current opinion about the prospects that LANDSAT V will last beyond March 1987?

Dr. CALIO. Oh, dear. What do I use as a data base?

Senator GORTON. I do not know. What do you use?

Dr. CALIO. I looked at LANDSAT I. That lasted what, about 7 or 8 years? I am trying to pull these out of my head. I guess LANDSAT III lasted—gee, I should not be quoting numbers. It is a scatter history on the lifetime of LANDSAT's.

Senator GORTON. Do they give any warnings that they are about to quit?

Dr. CALIO. They develop certain symptoms, I guess, that indicate whether they are going to survive or not. But I could remember LANDSAT III had symptoms for a long time, that we expected its demise about a year before it gave out. LANDSAT V looks very healthy and very strong, but it is hard to predict what will happen.

Senator GORTON. So we knock on wood and hope it will last longer?

Dr. CALIO. The design life was three years, for March of 1987, and I expect it to last its design life, through March of 1987. And as I understand, we are programmed for that.

Senator GORTON. On another subject, how far behind on the development schedule is NEXRAD development?

Dr. CALIO. From the original development, I think we are off about 6 months. But I think we revised that in the fiscal year 1986 budget submission. We revised the schedule and put a 6 months slip in it.

I would say we are probably within a month of that schedule right now. The people in the Weather Service and FAA are doing extremely well with the contractors. That program has pretty much stayed on schedule since we revised it and updated it.

Senator GORTON. What would happen if Congress refused to fund it out of the aviation trust fund and did not put the funding in NOAA's budget for it?

Dr. CALIO. I am trying to figure out. We would still proceed with the pre-production buy. We would be able to do that because of the FAA and the DOD contributions, and we would probably front-load that buy with their funds. That would give us about a six month lead time.

There is no—let me start that over again. I do not think there is any disagreement between the Administration and the Congress about the need for and the interests of developing those NEXRAD's and putting them into place. We are just discussing the source of funding.

Senator GORTON. So what you are saying is, please fund it, one way or the other?

Dr. CALIO. No, I am not saying fund it one way or the other. I think the proposal that is put forward by the Administration is a reasonable proposal. I know others do not agree with that, but there is some $7 billion or something in that trust fund, and we are looking at major deficit reduction targets.

And if we are going to meet the deficit reduction targets, it seems like a reasonable approach to funding that next portion of NEXRAD.

Senator GORTON. Dr. Calio, that has no impact on the budget at all. The source of those funds, the aviation trust fund, is still a part of the consolidated budget. From the point of view of the bottom line on deficit reduction, it does not make a damn bit of difference.

Dr. CALIO. I stand corrected. I understand.

Senator GORTON. So fund it one way or the other, please, even though you prefer the trust fund source.

On another subject, the reconciliation bill the President recently signed requires NOAA to follow certain procedures before contracting any functions pursuant to OMB Circular A-76.

What effects do you think this provision will have on NOAA's A-76 process, and have you begin to implement any changes since the reconciliation bill was signed?

Dr. CALIO. None whatsoever. We do it anyway. We try to make the notification here to the Hill. The bill says what, 30 days, a 30 day review.

Senator GORTON. I am sorry?

Dr. CALIO. I am sorry, sir. It would make no difference to us at all. We try to do it anyway before we make the final award and notify the members of Congress. This puts a 30 day review time in it, or notification time. So that would make no difference to us whatsoever.

Senator GORTON. How is that going to be affected by the fact that the position of the associate administrator responsible for it is vacant?

Dr. CALIO. None whatsoever. When the associate administrator was there, we had in place a team of 20 people who worked with the line elements of NOAA to implement that program. Those people are still in place. The responsibility for carrying out the program is still with those 20 people, and we will proceed.

Senator GORTON. The Administration has been strongly supportive of NOAA's efforts to modernize the data collection and management of the National Weather Service. Will this modernization effort lead to a consolidation or a reorganization of the Weather Service in any basic fashion?

Dr. CALIO. I am trying to understand your question, Mr. Chairman.

Senator GORTON. Are you going to reorganize the administration of the Weather Service?

Dr. CALIO. We are going to do that, but that is the result of several different technological changes: the NEXRAD's, hopefully some day soon the profilers, the automated surface observation system, and the introduction of the advanced weather interactive processing system. Those are the major drivers for restructuring of the Weather Service.

Included in that is an information collection, analysis, and distribution capability which will ultimately result in restructuring the Weather Service to be able to make that a tighter and more effective group.

I do not know if Dr. Hallgren wants to add any comments to that or not.

Dr. HALLGREN. I might say that with this technology coming in, we want to try and put the associated structure of the Weather Service in the best form to maximize the effectiveness of the technology, in order to provide services with a heavy emphasis on the warnings.

And that is what we are trying to do now. What is the best arrangement that will make the most use of the technology and provide the best service.

Dr. CALIO. If I may add one more thing and try to clarify that, Mr. Chairman. In addition to the restructuring in the Weather Service, it is probably going to have an effect of bringing the satellite service and information service closer together, because we are trying to set up information distribution systems there that are more efficient and effective, and they have to be an integral part of the restructuring of the Weather Service.

Senator GORTON. I would like to move to another subject.

As you know, Dr. Calio, one of the major issues before the entire Senate Commerce Committee is that of proposals for dramatic changes in the laws relating to product liability and the like.

Is this an area where your legal people, your general counsel, have examined with respect to NOAA? Can you tell us whether or not you believe that the Federal Government can be found liable for damages caused by inadequate weather information? How would that relate to contracting out some of your functions to the private sector?

Dr. CALIO. That is an interesting set of questions you put together. Let me first respond to the issue of liability.

As you recall, the out of round case was a difficult one for us, and we were surprised to see the determination by—let me get my background on that.

We were surprised with the outcome of that with respect to not maintaining that particular buoy. As you know, we have appealed that case in the First Circuit Court of Appeals. We have been sued for damages at about $1.2 million. That case has not been finalized yet in the First Circuit Court of Appeals.

The one that has really surprised us is *Springer* v. *United States*, where a small private plane crashed in South Carolina in December 1981, and the pilot and passengers were called. The plaintiff argues the FAA was liable because they did not warn the pilot of a low level wind shear and that the Weather Service, as a matter of fact, was not a party to the law suit. However, the judge found the National Weather Service liable for $1.3 million in that particular case, so that says to me that we could run into a series of litigations that could indeed pose very serious problems for our forecast capabilities.

I guess it would come to one thing or another. Maybe the question is we should not provide any public service weather forecast. That is one alternative. I do not know where this could escalate to if we look at this kind of liability.

We have an outstanding group of professionals that use the best techniques and the best tools available to them to try to be able to forecast the weather. We try to maintain that capability within reasonable financial constraints, and they do an outstanding job. They continue to be liable for not being able to 100 percent accurately determine the weather for the next day or 3 days.

I think we have to rethink what kind of public services we provide for the future.

Senator GORTON. Is that exposure to liability increased by contracting out in your view, decreased by it or is contracting out irrelevant?

Dr. CALIO. My own personal view is it is irrelevant.

Senator GORTON. Is this something you have been advised by your lawyers on?

Dr. CALIO. No, I have not. The only reason I say that again is that in my background and experience the responsibility for carrying out those functions primarily rests with the government. We should be able or we must be able to specify to our own civil servants what the tasks are and what functions have to be carried out to enable us to provide a forecast.

If those functions are carried out by someone else other than a government employee, I do not understand what difference that would make. The responsibility, however, would still rest with the Federal Government.

Dr. Hallgren wants to add something.

Dr. HALLGREN. We have had a policy for a substantial period of time that we would do our contracting out in the observing area, and we have done that. The contractors follow the procedures that are set in the various documents in making those observations, and as long as they follow those procedures we are in good shape I think.

We have also had the policy that forecasting is done by the government people, and that type of split—the observing function we contract out, the forecasting we have held within the government—I think holds us in reasonable shape for the situation that is unfolding.

There is clearly an indication by the number of suits that have taken place that there is more pressure to improve the way in which we particularly disseminate information, and the way in which we handle our instrumentation is where they are attacking.

Senator Gorton. Another question on this subject: Has the Weather Service had any input into the administration's recent suggestion for changes in law relating to liability? I know the Department of Commerce is involved in it.

Have you talked to your secretary about it? Secretary Baldrige came to me to speak in favor of the administration's position on this subject.

Dr. Calio. That was primarily product liability, was it not? I believe so.

Senator Gorton. His recommendations, at least for State if not Federal actions, were well beyond product liability. Have you talked to him about this?

Dr. Calio. We have not brought this specific issue before him in this discussion, but I have had general discussions with him in the whole arena of liability, product liability and insurance.

I am being advised now that the Justice Department task force has been put together to look at tort liability. I do not know what means, as I am not a lawyer.

Senator Gorton. That is a rather general term.

My real question is is it going to cover tort liability of the Federal Government in instances such as the Weather Service with respect to its forecasts?

Dr. Calio. I am being advised by my staff that some of my staff people have been working with the Department and with the Justice Department in looking at these particular aspects of liability.

Senator Gorton. I think, Dr. Calio, you would be well advised to do so while Congress is working in this area. Your whole question, if there is some serious alternative that sometime in the future the Federal Government would have to abandon the Weather Service because of potential liability for mistaken forecasts, it becomes a very central issue.

We should consider whether or not we want to eliminate or restrict that kind of liability, and we can only do that if you have made a recommendation on this subject.

Dr. Calio. All right.

Senator Gorton. I would like to go to a related subject, one which is somewhat parochial from the perspective of my own state, the El Nino phenomenon.

Will you tell me what you have learned through your research about that phenomenon? I understand some experts are predicting that it may reoccur this year. Do you feel that to be likely? Can you make a prediction in that connection, and is possible liability for mistaken predictions a factor in whether or not you are going to do anything?

Dr. CALIO. That is interesting. That last one brings up an interesting aspect.

May I turn to an expert on that, Dr. Alan Thomas, the Assistant Administrator for Oceanic and Atmospheric Research.

Senator GORTON. Doctor, why not come up here and talk into the microphone so the reporter can hear you?

Dr. CALIO. Dr. Hallgren is going to speak for the prediction.

Dr. HALLGREN. First of all, Mr. Chairman, we do not view it as a prediction. What we have been putting out are statements with regard to what is happening down in the tropics to the west of South America and Central America.

What we are saying is that more of the indicators at this point in time that are showing that we might be entering a new phase and entering a period in which we might have an El Nino.

We have not made a prediction, though, that there will be. That is always difficult to handle in the press, but we are saying that there are a number of indicators that say that an El Nino may be about ready to begin.

Senator GORTON. You do not intend to go beyond that?

Dr. HALLGREN. Not until we have a full range of indicators. For example, there are now models that have been developed that try to prescribe whether an El Nino is going to take place or not. Some of the models say there is one coming. Others say not at this point in time.

So we have been trying to be cautious with regard to that.

Senator GORTON. Is this posture related to any potential liability?

Dr. HALLGREN. No, I certainly had not been thinking down that line, and the people at the Climate Analysis Center at Suitland were not worried about the liability.

What they were worried about was making statements that are well founded scientifically as to what is taking place. We certainly do not want to raise the spectre that the El Nino is coming and it is going to be the same as the last one, because the last one was a once in a hundred year event.

Of course, the probability of the next one, when it does come, being as strong as the last one is very small.

Senator GORTON. Have you learned a good deal through your research programs about this phenomenon? Has this been one of the research programs of NOAA in the several years since the last El Nino?

Dr. CALIO. Yes, it has. As a matter of fact, this project I talked about, TOGA, Tropical Ocean Global Atmosphere program, is geared pretty much to try to understand what is happening as far as the air scene or action is concerned, the transfer of energy from the ocean to the atmosphere, trying to understand some of the manifestations of this, the shifts in pressure regions between the Pacific and the Indian Oceans, and actually measuring the thermoclines or the variation of where the thermoclines occur throughout the Pacific region.

Let me ask Dr. Thomas again, who runs the research activities, to comment on that.

Dr. THOMAS. In addition to what Dr. Hallgren and Dr. Calio mentioned, through our program we are involving a broad spectrum of the scientific community in Toga. For example, a panel of the National Academy of Sciences which is involved in giving direct advice is chaired by a distinguished scientist from the University of Washington.

We also have a panel which we have formed under our program office to look at the specific question that you asked us in terms of what are the signals that may be showing whether there is an El Nino or not, and we will be calling together this group on a regular basis to provide updates to the Climate Analysis Center and other scientists that are interested in El Nino and the general public.

So this has been a major focus of the research. The research has implemented an observational system in the Equatorial Pacific as part of our program and has funded a number of research and modelling studies to try to simulate El Nino phenonemon.

Senator GORTON. Is this one of the areas where you are proposing to cut back on research money this year, Dr. Calio?

Dr. CALIO. We have $2.5 million in TOGA, and the total climate program is about $34 million. As I mentioned at the outset, looking at the whole atmospheric research area, we have $31 million appropriated in 1986, and we are recommending $75 million in 1987.

I believe we took about $1 million out of TOGA. We cut TOGA in half in the notion of being able to bring in other nations.

Senator GORTON. At this point, I have finished my questions. I suspect that we may have some additional ones to submit to you. Of course, as you know, we will be very anxious to have the official position of the administration on AMSTAR as quickly as possible.

In any event, we thank you for you help and your cooperation at this point very, very much.

Dr. CALIO. Thank you very much, Mr. Chairman.

[The statement follows:]

STATEMENT OF HON. ANTHONY J. CALIO, ADMINISTRATOR, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, DEPARTMENT OF COMMERCE

Mr. Chairman and Members of the Subcomittee: I appreciate the opportunity to discuss with you the National Oceanic and Atmospheric Administration's (NOAA) programs and policies.

My testimony will highlight major activities of the National Weather Service, the Office of Oceanic and Atmoshperic Research, and the National Environmental Satellite, Data and Information Service, based on our FY 1987 budget submission. The FY 86 currently available figures shown in the FY 87 budget request do not reflect the 4.3% reduction as a result of the Gramm/Rudman/Hollings sequestration. However, this does not affect the figures for FY 87 because the FY 87 request is within the deficit reduction required under Gramm/Rudman/Hollings.

THE NATIONAL WEATHER SERVICE

NOAA's FY 1987 budget proposes full funding for the development and acquisition of the Next Generation Radar (NEXRAD) and development of two major systems for the National Weather Service (NWS).

These systems collectively will enable us to modernize the weather service with the latest technology and science to improve our severe weather and flood warnings and forecasts.

Major system upgrades planned over the next decade include Automated Surface Observing Systems (ASOS) to reduce time-consuming manual observations; Next Generation Weather Radar (NEXRAD) with doppler capability and sophisticated software to provide nationwide coverage for timely, accurate detection of severe storms and floods; and an Advanced Weather Interactive Processing System (AWIPS) to integrate, process, and transmit high-volume radar, satellite, upper air, and surface observation data.

The basis of our local warning program is the weather radar. We remain committed to replacing the existing obsolete weather radars with an effective, modern system which will serve the Nation well into the next century. NEXRAD is a joint FAA/DOC/DOD effort to develop an advanced doppler radar system. Our FY 1987 budget requests financing of $47.5 million, from the FAA-administered Airport and Airway Trust Fund, because aviation is the major beneficiary of the program and the FAA determines the programs' technical specifications and siting requirements. The deployment of NEXRAD units will begin in FY 89. The Validation Phase will be completed by the end of this year and a production contractor selected.

In the last few years we have witnessed an exciting series of developments in our ability to forecast small-scale weather phenomena. At the National Severe Storms Forecast Center (NSSFC), we have used a pilot computer-based system which permits forecasters to integrate radar, satellite, and other meteorological data when making forecasts.

The Program for Regional Observing and Forecasting Services (PROFS) system, developed at the Environmental Research Laboratories, applies interactive computer procedures to improve our short-range severe weather warnings and alerts.

To make the features of the PROFS computer system available to NWS field offices, our FY 1987 budget requests $9.7 million to continue competitive system design and communications upgrade activities associated with deployment of the Advanced Weather Interactive Processing System (AWIPS) in FY 1990 through 1994. The AWIPS system, which will replace the existing AFOS system, will improve the communication and processing of observational data and forecasting products. AWIPS will increase our ability to provide better warnings and improved forecasting of small scale severe (mesoscale) weather events such as thunderstorms or tornados. It will also provide the capacity for transmitting and fully utilizing larger and more frequent observational data.

The President's FY 1987 budget request supports the basic mission of NOAA to provide essential forecasts, warnings, and advisories for the protection of life and property and to promote economic development by supplying other government agencies and industry with timely weather and climate services. We propose to decrease or eliminate funding for programs which are no longer necessary, which are low priority, or which are not Federal responsibilities including Landsat subsidies and the Second Polar Weather Satellite.

To reduce overhead, our FY 1987 budget proposes both, the consolidation of the Pacific and Alaska Weather Service regional offices and the closing of the Southern Regional NWS Headquarters, transferring its responsibilities to the Eastern and Central Regional headquarters. These offices provide field managerial support but have no forecasting or data gathering responsibilities. Staff reductions in the FY 1987 budget will result in a more efficient staff structure without detriment to service delivery. Also, we are seeking to discontinue FY 1986 budget add-ons for the Susquehana River Basin Flood Warning System, the Colorado River Basin Flood Warning Systen, as well as the prior year add-on for the NOAA Weather Radio emergency power program because those projects have been completed.

Providing specialized weather services for specific user groups is not a Federal responsibility. Some agricultural, fruit frost, and some fire weather services are discontinued in our FY 1987 budget. While continuing to provide fire weather services for Federal forest lands, we will eliminate non-wildfire support to non-Federal agencies. General public forecasts will be available to non-Federal entities; specialized forecasts should be provided to industry by private meteorological firms. Our goal is to devote resources to improving our ability to get fast, accurate weather warnings and alerts to the general public.

OCEANIC AND ATMOSPHERIC RESEARCH

NOAA's Office of Oceanic and Atmospheric Research conducts research and development to improve NOAA services and resource management. This research is used by NOAA components, other Federal agencies, the private sector, and for atmospheric, marine and space research. OAR's research programs are diversified; for example, technology development to improve prediction of metorological and climatic conditions; and investigations of the fundamental physical and chemical properties of the atmosphere, hydrosphere, and solar-terrestrial environments.

NOAA's FY 1987 budget requests enhancements to accelerate three atmospheric research programs—hurricane prediction research (+ $1.0 million), a temperature/humidity profiler (+ $0.5 million) and the Radiatively Important Trace Species (RITS) program (+ $1.0 million).

NOAA's Atlantic Oceanographic and Meterological Laboratory and Geophysical Fluid Dynamics Laboratory in collaboration with our National Meteorological Center and National Hurricane Center, will take advantage of recent advances in hurricane modeling, computing power, and data collection techniques, to refine and implement a second-generation hurricane prediction system.

OAR's Wave Propagation Laboratory (WPL) has begun a program to develop procedure, and deploy an experimental Doppler radar system called PROFILER. The PROFILER system is for remote measurement of wind profiles. This year we will procure 30 wind PROFILERS for use in a demonstration project.

In FY 1987 we propose to begin developing the complementary thermodynamic profiler system which is a passive microwave system for measuring temperature and humidity profiles. A combined wind/thermodynamic profiling system, when developed fully, has the potential for replacing the current radiosonde system at a lower operating cost and with far more frequent observations.

The RITS program, which started in FY 1985, will test the theory that increases of certain atmospheric trace gases and aeroslos (nitrous oxides, methane, chlorofluoro-carbons and tropospheric ozone) contribute as much to the warming of the earth's atmosphere as increases in carbon dioxide. The so-called "greenhouse effect" which results from atmospheric warming, in the long term, could cause significant global climatic changes affecting rainfall and food production patterns.

We are seeking the same level of funding in FY 1987 for NOAA's participation in the National Acid Precipitation Assessment Program as in FYs 1985 and 1986 ($4.4 million). We are developing techniques to measure dry deposition of acidic materials and continuing research on the source, extent and transport of wet and dry acidic materials.

In FY 1987 NOAA will continue its research into global climate variability related to El Nino. This research is now conducted by several nations under an international program called the Tropical Ocean Global Atmosphere (TOGA) program. NOAA is the lead U.S. TOGA participant. This program shows great promise in predicting year-to-year climate variations. Recent models have simulated oceanic conditions in the equatorial Pacific during several past events, including the 1982–83 El Nino. One aim of the program is to adapt one such model for operational use in 1986.

Understanding the ocean's role in climate variability over longer periods is the goal of the Subtropical Atlantic Climate Studies (STACS) program. It develops techniques to monitor the processes by which the North Atlantic Ocean transports excess solar heat poleward from equatorial regions. After successfully developing an electromagnetic technique to monitor the Gulf Stream off Florida, STACS will extend its investigation to the Caribbean Sea and Windward Passage to determine the variability and magnitude of the Florida Current's heat tranpsort role and variability.

Our FY 1987 budget will support NOAA's Space Environmental Laboratory to provide solar-terrestrial data and forecasts for government, industry and foreign governments 24 hours-a-day/7 days-a-week. This information is vital for communications and air and space travel which can be disrupted by magnetic or particle storms caused by solar flares. The budget will also enable the Space Environmental Lab to continue a core program of applied research to improve forecasting techniques.

Our FY 1987 budget will also maintain a core research program ($3.0 million) at the Great Lakes Environmental Research Laboratory (GLERL). The focus will be on research activities that are clearly Federal responsibilities (for instance, support for the U.S.-Canada Water Quality Agreement).

In FY 1986, NOAA began a Fisheries Oceanography Coordinated Investigations (FOCI) initiative to understand and predict the effects of environmental changes on major U.S. fishery resources. This is a multi-disciplinary research effort conducted on a large spawning area of pollock recently discovered in Alaska's Shelikoff Strait. We believe that we can achieve savings of $1.0 million by deferring certain elements of this laboratory and field research program. The remaining $2 million core program will meet the long-range goals of the FOCI program.

One objective of NOAA's research on marine warning and forecasting is to develop advanced sea ice forecasts as an aid to fisheries and navigation. In cooperation with the Office of Naval Research, NASA and the Coast Guard, NOAA has completed a study of sea ice drift and ice edge behavior in the Bering Sea. NOAA will begin work in the Chukchi Sea in FY 1987.

We continue to believe that savings can be achieved in some OAR programs by: 1) eliminating general taxpayer support for programs which primarily benefit state, local or private sector interests; and 2) focusing limited resources on the highest priority research and development activities in support of NOAA missions. The former category includes funding for the National Sea Grant College Program, the National Undersea Research Program and the State/Federal Weather Modification Grant Program which we believe should be fully supported by non-Federal public and private sources.

Recognizing the need to provide support for the highest priority NOAA research missions, the FY 1987 budget proposes to: defer additional research on the physical, chemical, geological and biological processes at seafloor spreading centers ($1,800k); reduce funding for PROFS that is not needed to support the National Weather Services AWIPS-90 program ($2,000k); and, postpone the acceleration of the program on severe mesoscale convective precipitation systems until new observing and data processing capabilities (such as PROFILER, NEXRAD and AWIPS) are in place ($2,500k).

NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE

Budget items of the National Environmental Satellite, Data and Information Service of interest to the Subcommittee include the procurement and operation of polar and geostationary weather satellites, and the acquisition, archiving and dissemination of environmental data and information.

In FY 1987 we are proposing a net decrease in funding of approximately $72 million. Most of the decrease reflects savings associated with conversion to a single polar-orbiting satellite from the two-satellite system. Following the launch of NOAA-G, the one-polar system should maintain two operational SARSATS through 1990, no significant degradation in the quality of weather forecasts from operating a one instead of two-polar system is anticipated. The improvements in the GOES satellites will supplement the one-polar satellite over the western hemisphere. Also, soundings are available from defense polar satellites. The decrease in the geostationary satellite program reflects normal phasing of funding in spacecraft procurements.

We are proposing an initiative to establish a U.S. Mission Control Operations Center for satellite search and rescue operations. For this initiative, an increase of $3.78 million is requested to establish the ground processing system needed to receive, process, and disseminate emergency alert and location data for the COSPAS/SARSAT program—an international cooperative effort that uses Soviet and U.S. environmental satellites to detect and locate pilots and mariners in distress. The U.S. Mission Control Operations Center will be the regional alert and distribution center for both North and South America.

In our request, funds for polar spacecraft procurement and launch have been decreased by $62.23 million. The remaining funds will provide for the procurement of spacecraft and launching services needed for the conversion from the current two-satellite system to a one-satellite system. Conversion will take place when the NOAA-G satellite, planned for launch in 1986, fails (probably some time in 1988).

We are requesting an increase of $3.05 million for polar satellite ground systems. These funds are needed in FY 1987 to refurbish and upgrade current ground system components and to add additional components that will be required by follow-on polar-orbiting satellites. These improvements are mandated by changes in the sensing instruments and communications characteristics of the modified NOAA-J and the follow-on NOAA K, L, and M spacecraft. The upgraded ground system changes must be in place by FY 1990 to support the planned launch of NOAA-J.

A net decrease of $25.45 million requested in funding for geostationary spacecraft procurement and launching. This decrease reflects completion of funding (−$43.4 million) for GOES-G and H with the launch of these two spacecraft in FY 1986. The decrease is partially offset by planned increased funding to procure GOES I-M spacecraft and associated launch services.

A net increase of $12.64 million is requested to support the geostationary satellite ground system. A planned increase of $14 million is requested for the GOES-NEXT ground system, to continue efforts initiated in FY 1986 to begin the transition to ground equipment and facilities to the configuration required by the GOES-I through M satellite series. The new ground system will accommodate concurrent operations with two generations of GOES satellites and allow for expanded capabilities for both types of spacecraft. The above increase is offset by a planned decrease of $1.46 million associated with the near-completion of a multi-year GOES ground system modification that began in FY 1983. Remaining funds will allow completion of this effort in FY 1987.

A decrease of $1.4 million is requested for Landsat operations, reflecting a reduced level of services for FY 1987. No funds are requested to subsidize Landsat commercialization as this program principally benefits special interests and should be funded by those interests, not the Federal Government.

Funding for environmental data and information services will continue at approximately the FY 1986 level. In this program, NOAA provides global environmental data and information to commerce, industry, agriculture, science and engineering, the general public, and all levels of government.

Mr. Chairman, I will answer any questions you or the other Members of the subcommittee may have regarding NOAA's FY 1987 budget.

QUESTIONS OF SENATOR HOLLINGS AND THE ANSWERS

Question. What role do you believe NOAA should play in satellite data management between now and the year 2000.

Answer. NOAA has two major responsibilities for data management, one pertaining to civilian operational satellites, and one related to historical environmental data, that are expected to continue between now and the year 2000. As the agency responsible for operating GOES and POES, NOAA will continue to ensure that data are available to the user community at the least possible cost. Both direct readout services and access through dissemination channels such as GOES TAP land lines and the Global Telecommunications System (GTS) are provided. Access to the historical data base is provided to retrospective users through the National Climatic Data Center. With Landsat, we have ensured through our contract with EOSAT that data are disseminated in accordance with P.L. 98-365 on a nondiscriminatory basis. We are assessing alternatives for continuing our data management and distribution systems over the next decade for both real-time and retrospective data. Our goal will be to provide cost effective support for NOAA's data distribution mission needs through the 1990's and to provide access to real-time and historical data. Through these efforts, we believe NOAA can continue to serve as an environmental data manager and provide access to both real-time and retrospective data.

Question. A deluge of ocean sensing data from satellites will commence in the late 1980's and early 1990's. What is NOAA doing to prepare for this development. What is NOAA's current capability for handling this data and what changes will have to be made in order for NOAA to be the principal U.S. data handler for ocean sensing satellites? What would be the approximate costs of such an upgrading of the NOAA data capability?

Answer. NOAA has several agreements in place or near completion to ensure access to ocean sensing satellites. The NROSS Memoran- dum of Agreement between the Navy, Air Force, NOAA, and NASA designates NOAA as the civilian dissemination point for NROSS data, and gives NOAA responsibility for NROSS data archiving. The Shared Processing System, now being implemented, provides a satellite link which will be used to deliver NROSS data to NOAA for dissemination. In addition, NOAA is negotiating an agreement with the European Space Agency to exchange global data sets of NROSS and ERS-1 data within hours of acquisition. We are considering various ways to maintain our communications capability as these new sensors come on line to ensure access to the user community. Our plans for archiving ocean satellite data are being developed. We have been working closely with NASA in the NASA Ocean Data System (formerly PODS) and internationally through the Committee on Earth Observations Satellites (CEOS) Working Group on Data to ensure that our plans are consistent with user requirements and other agency practices. No specific changes are required for NOAA to be the principal U.S. data handler for ocean sensing satellites. We recently began transmitting ocean data including output from the Navy's facility in Monterey, over the National Weather Service Family of Services System and we will soon include unclassified GEOSAT data over this network.

Question. What are the implications for the United States of a failure to provide sufficient data handling capability for these satellites? For example, how will data from the European and Japanese satellites be conveyed to the Navy if NOAA is not able to transmit these data?

Answer. With respect to the European ERS-1 satellite, NOAA is concluding an agreement for exchange of global ERS-1 data products for a comparable set of NROSS data products within hours of acquisition. These data can be relayed to the Navy via Shared Processing. We have not made any specific arrangements for access to data from either the Japanese MOS-1 (primarily a land-oriented satellite) or JERS-1. If there are Navy requirements for data from Japanese spacecraft, NOAA will undertake to establish an appropriate cooperative arrangement for exchange of data with Japan. We believe that NOAA systems, together with the Shared Processing System, will provide sufficient transmission capability to meet real-time ocean data needs.

Question. What do you believe are the most important technological priorities required for significantly improving marine weather forecasting? How important are the polar orbiters to marine forecasting? Are there less expensive ways to acquire the necessary data?

Answer. The two technological priorities critical for significantly improving marine weather forecasts are the quantity and quality of marine observations and the models into which these data are assimilated. These two areas provide the greatest opportunity to improve marine short, intermediate, and long-term forecasts, as well as enhance the long-term forecasts over the North American continent, Hawaii, and U.S. Trust Territories. NOAA is focusing on these two areas as follows. For the global oceans, NOAA plans to use other nation's polar-orbiting satellites as discussed in the response to Questions 2, 3, and 6. This will improve the quality and quantity of data over the open oceans. Polar satellites are necessary for open-ocean coverage because: a) the technology does not permit geostationary satellites to acquire quantitative oceanic data; b) NOAA operates two geostationary satellites that do not provide global coverage; and c) polar regions can only be covered by polar-orbiting satellites. The coastal regions will be further enhanced by improvements in our National Data Buoy Center deployment of buoys. These buoys are utilized in our coastal regions because many of the satellite sensors do not provide oceanic environmental data in regions closer than 30-75km of the shore. Our current forecasting models operate on the historical synoptic times at a very low resolution for the global grid system (65 x 65 grid for the global models--equivalent to 200km x 200km at 45= latitude). To improve model capability, the models should operate on the synoptic times of satellites because the greatest majority of data is acquired by satellites for essential meteorological data and will be acquired by satellites in the very near future for oceanic measurements from non-NOAA satellites. We are planning to increase the grid system to about a 50km x 50km grid, but this will be accomplished in steps. This model system is expected to improve medium and long-range forecast of marine data and also offers an improvement in the forecast of weather over land.

Question. NOAA's ENVIROSAT-2000 study indicated that over a 10-year period no savings are made by cutting back to a one-polar satellite system. Do you agree with the study's analysis and conclusion? Please explain.

Answer. I do not agree with the interpretation of NOAA's ENVIROSAT-2000 study[1] that holds that there are no savings from cutting back to a one-polar satellite system. The study specifically excludes satellites of new design. However, new designs are being planned by NOAA within the future 15-year period the study addresses. The study also assumes that requirements are met using the fixed launch schedules and four-month launch call-ups demanded by the study's planning scenarios. I view it as impossible to guarantee a clockwork launch profile over such a long period. There are clearly savings associated with a one-polar program where satellites are launched every 18 months as compared to a two-polar program where satellites are launched every 12 months. As a result, under a one-polar program, as requested in the President's Budget, over $114M in savings are achieved for the period 1987-1991. My judgement is that there are cost savings and an acceptable risk inherent in a carefully managed one-satellite polar system configuration.

Question. What steps has NOAA taken to develop a means for providing NROSS data to the private marine community in near-real-time? Will NOAA require additional data handling capacity to operate as conduit for NROSS data? It so, what are your plans for acquiring this capacity?

Answer. The shared processing system, now being implemented, provides a satellite link which will be used to deliver products derived from NROSS data to NOAA for dissemination to the private marine community. We are looking to see whether our current capabilities are adequate for archiving and disseminating NROSS data.

Question. Around half of NOAA's work on storm surge simulations for 25 key basins along the Atlantic and Gulf coast has been completed. For which basins have the simulations not yet been done? When do you expect to complete all 25 basins?

Answer. The basins for which simulations have not been completed are: Boston Harbor, MA Narragansett/Buzzard Bay, CT New York/Long Island Sound, NY Delaware Bay, DE Atlantic City, NJ Ocean City, MD Brunswick, GA/Jacksonville, FL Lake Okeechobee, FL Biscayne Bay, FL Florida Bay, FL Apalachicola Bay, FL Matagorda Bay, TX Simulations are being completed at the rate of 2 basins per year. Depending on the success of continued cooperative funding arrangements with other Federal and state agencies, the 25 key basins should be completed during FY 93.

Question. Please explain how NOAA's cooperative institute program functions and specify how it advances the agency mission.

Answer. The current cooperative institute program of NOAA has created centers of excellence in the environmental sciences, focused at present on meteorological and atmospheric sciences. We have provided seed resources to the U.S. university system and provide civil-servant scientists who work in the university research program. The number of government scientists working in university research depends on the maturity of the program. The approach has been very effective in three areas. First, the university programs are responsive to our satellite research needs. Second, our NOAA scientists are able to work closely with many of the best scientists in specific fields without increasing the number of NOAA federal employees. Third, as these centers of excellence mature, additional research resources from other Federal and State agencies are brought into these institutes through contracts and grants. The Agency's mission is advanced by having specialized groups without an increase in both equipment and personnel. I believe that our current programs is strong because of the centers of excellence at the University of Wisconsin, Colorado State University, University of Maryland, University of Texas, and University of Missouri.

Question. To what extent does NOAA contemplate making its satellites available for research experimentation? What technical and budgetary limitations affect such use?

Answer. We have a long history of successful cooperation with the research community in making our operational data available for research purposes, scheduling the operation of the satellites to gather data for major field experiments, and accommodating research payloads on our spacecraft. The limitations that affect such use are non-interference with our main operational priorities which support the National Weather Service and the budgetary limits on the funds authorized for our operational missions. The experimental sensors we have flown for NASA for example, the Earth Radiation Balance Experiment now on NOAA-9 and the VISSR Atmospheric Sounder experiment on GOES-6, have been fully funded by NASA. We are discussing with NASA some candidate research payloads for the GOES I-M series. The limitations are total spacecraft weight and the amount of earth viewing area that is available beyond what is needed for the operational sensors. we are talking with the Air Force about flying some experimental environmental monitors on the NOAA series. In both instances we expect NASA and the DOD to pay for their sensors and the appropriate spacecraft integration costs.

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[1] ENVIROSAT-2000 Report, Optimum Management Strategies for the NOAA Polar-Orbiting Operational Environmental Satellites, 1985-2000, April 1985.

Question. The Advanced Microwave Sounding Unit (AMSU) that is to fly on the next generation of polar orbiters has the capacity to penetrate cloud cover. Would an AMSU-like instrument on a geostationary environmental satellite help to improve hurricane prediction?

Answer. A microwave sounder or imager on a GOES would be expected to benefit general and severe weather forecasting. However, it is not yet technically feasible and the technology breakthroughs would have to bring cost, weight, and power requirements within practical limits.

Question. A number of data users in the research community have raised concerns over the costs and delays in environmental satellite data distribution. Please describe the current system for research data distribution. How do you believe such expansion could be accomplished and at what cost? Would it be feasible to rebroadcast satellite data to researchers via a communications satellite, using a meteorological frequency?

Answer. Currently, satellite data are available in two modes. Users may receive data directly from the spacecraft as they transmit them to the ground, or they may order individual selections of data from our Satellite Data Services Division (SDSD). Direct reception entails the cost of establishing and operating the receiving facility, but no access fees are required. Data obtained from SDSD are provided at the cost of reproduction and transmission, in accordance with government policies.

Question. Last year the Administration sought funding to upgrade the geostationary satellite ground stations to increase data transmission capability, but funds were not appro- priated. Please describe the problem you were seeking to correct with such an upgrading. What are you doing now to cope with the situation? Why did the Administration decide not to ask for funds this year.

Answer. Maintenance and operation of aging equipment is an increasing problem. The proposed upgrading would have provided broadcast distribution of satellite and other environmental data via commercial communications satellite. This approach would have replaced aging equipment with a system which would have accommodated NOAA data dissemination requirements associated with new sensors and satellites, e.g., GOES I-M currently being designed and scheduled for launch in 1989. Instead, we have continued to transmit analog facsimile images as we have done since the GOES became operational in 1973. This requires continued maintenance of the 1970's computer equipment until an updated system can be placed in service and the existing equipment can be phased out. The request for funding this year (FY87) was withdrawn so that the procurement approach would be service-oriented rather than implementing a wholly Government-owned data network.

Question. The present polar orbiting satellite system includes an ozone monitoring instrument, known as the Solar Backscatter Ultra Violet Ozone Monitoring Instrument (SBUV), which is a vital element of NOAA's responsibility under Public Law 95-95 to monitor the state of the stratosphere on a longterm basis. What plans does NOAA have for continued use of the SBUV in the polar program through the NOAA-M launch?

Answer. The current SBUV/2 procurement delivers four instruments for operational use, the first of which is now flying aboard NOAA-9. The three remaining instruments, which are used only on afternoon satellites, will be flown on NOAA H, I, and J. (NOAA G, the next scheduled, will be launched into a morning orbit.) In the proposed one-polar system, this will provide ozone measurements through about mid-1992. The measurement of ozone to meet the requirements of P.L. 95-95 in the period beyond 1992 is now under review in NOAA, with new space instruments and surface measurement techniques both being considered for the 1990's.

Senator GORTON. Dr. Frank.

Doctor, we are delighted to have you here, and we would like to hear what you have to say.

STATEMENT OF DR. NEIL L. FRANK, DIRECTOR, NATIONAL HURRICANE CENTER

Dr. FRANK. Good afternoon. I had an interesting experience. Last year I got out into the State of Washington for a week, so I had a very pleasant stay out there.

They told me on Monday that had I been there I would have seen spring. They had a beautiful day with 71 degrees.

I believe that you have some pictures in front of you. I think it is well at times to see where we are in terms of the hurricane area.

Senator GORTON. I do not believe I do. Oh, wait a minute, someone has just handed them to us.

Dr. FRANK. It is kind of interesting to see what happens in the coastline in an area where we have had storms in recent years.

In 1979 we had a hurricane by the name of Frederick on the Alabama coast at a placed called Gulf Shores, AL. This is a little community on the east side of Mobile Bay. Then we had another hurricane there this year by the name of Elena.

It is kind of interesting to see what happens. If you will take a look at your first set of pictures there, you can see that there was a condominium there, a beachhouse condominium, a U-shaped condominium. After Frederick, 1979, both wings were totally destroyed. You can see in the upper right. Down in the lower left it was rebuilt in 1982.

Then we had some winter storms we think probably associated with the El Nino that came out of the Gulf of Mexico, and each one of these had wave actions with them. It destroyed the seawall.

If you will look at the next page in the upper left, you can see that it undermined both wing units of that condominium. Then in the lower left after Elena 1985, here we have now the same seawall destroyed, and both of those wing units were damaged. So we are on the third generation of damage in that unit since 1979.

If you look on the righthand side there you can see what the problem is. You notice where the beach is retreating? Right where we put a seawall. You put a seawall, you interrupt the natural cycle, and you are eventually going to have the beach retreat.

Another interesting series of pictures on the next page. You see the Tiki Restaurant in the upper lefthand corner. In the lower left you can see what the Tiki looked like after Frederick, 1979. The building was totally gone. I am happy to report that the owner of the restaurant sold that property off to a developer, who put his condominium that you see in the upper righthand corner. Then we had Elena come by in 1985, destroyed the seawall and swimming pool, and did some structural damage to the foundation of that building.

A community that was not a problem for us to evacuate before Frederick in 1979 because maybe only 1,000 or 1,500 people lived there, we have a major problem with now because 15 new condominiums like this have been built in that community within the last 5 or 6 years.

Senator GORTON. Is the building of those condominiums and those seawalls, what you were just saying, does that affect beach action adversely?

Dr. FRANK. Yes, sir, particularly when you have a rising sea level like we have had over the last century in the northern hemisphere. When you have a rising sea level, then the ocean waves reach up and grab that sand there and erode it back out to sea.

If you plan buildings over the big seawalls, then you are going to have major, major problems.

Senator GORTON. Is this particular set of pictures you are showing us in an area which is affected by our barrier island legislation?

Dr. FRANK. The barrier island legislation is essentially for undeveloped islands. This was a developed island, so you continue to have development there. It is affected by the Federal Flood Insurance Program, so that you have to build above certain levels now when you put new construction there.

Senator GORTON. Are these buildings that you are showing us here eligible for Federal insurance?

Dr. FRANK. I am not sure what the status of the condominiums are. If you go back to that first picture, yes, it is, because you see the ground floor was parking, so they could park under the ground floor. The floor level was 11 feet above mean sea level. Hopefully that was going to be high enough not to be affected by a 12-foot storm surge, but what we did not account for was you are going to have wave action on top of the storm surge which literally knocked the building down.

So the new Flood Insurance Program standards now call for the 100 year flood levels plus another 50 percent to account for the wave action.

Senator GORTON. Thank you. Go ahead.

Dr. FRANK. Now, the last set of pictures I want to show you very quickly illustrates to you that you do not know how the building is built. You only know how it is engineered.

In the lower righthand corner you see the Pepper Tree Condominium in Panama City Beach, FL as it appears today. This is actually after Elena in 1985. Of course, Elena only brushed this coast, so there was no major damage.

All the units have been sold. The building is then completed, but I wonder if the residents there really know what the property really looked like after Eloise in 1975. Of course, that raises the interesting question, would buildings like this survive a major hurricane?

Engineers tell me if it is on pilings and all integrated together, a building like this would probably survive. If you look in the upper lefthand corner now, you can see after Eloise that the seawall was destroyed. In the upper righthand corner you can see that the walls of the ground floor were actually knocked out, and the waves went underneath the foundation of that big building and excavated three or four feet of sand, and you can see it was on pilings.

In the lower lefthand corner, very interesting. If you take a close look at those pilings, out of the 90 pilings that were there 30 of them had no concrete around the top of them.

I was showing these pictures a couple of years ago, and a young man came up, and he said, do you know what happened there? I said, no, how do you know? He said, I worked on the building. I said, well, tell me. He said, we drilled the holes for the pilings, poured the concrete down into them and left the metal rod sticking exactly as you are supposed to, then constructed the forms, the support members or the foundation, essentially, of that building.

He said a few days before we poured the concrete it rained. Sand washed down in the bottom of the forms, and we never cleaned it out. So you really do not know how the buildings have been built, is what I am saying.

Now, the essence of these pictures, I think, would illustrate to you that we have a growing hurricane problem. In spite of the fact that we are aware that there is a problem there, it is a growing problem, and as far as no one's responsibility, there is a desperate need to move on with our forecasting. We are very excited about some of the things that have been proposed here this morning by Dr. Calio.

There are two things that you need to know if you are going to forecast where a hurricane is going. Number one, you need to know what the hurricane is doing. We do that very well through the eyes of the weather satellite and particularly the type in the tropics. We appreciate the orbit around the equator because we get pictures every 30 minutes that way, both day and night, and then we can add a dimension of motion.

Senator GORTON. How is it affected when you only have one?

Dr. FRANK. We are not blind, but we do not see as well as if we had two. When we had the satellite to the east and one in the west, we could see all the way across to Africa. My office has the responsibilty for marine warnings all the way to Africa and marine forecasts on hurricanes.

If we had the west satellite, we could see all the way to the Hawaiian Islands and up into Alaska. Now with only one, we are a little bit narrower in our view, so out on the eastern Atlantic I do not see very well, and of course we do not see very well in Hawaii. So we need the two satellite operations to get a good look of our entire area of tropical responsibility.

Then, of course, if we see something on the statellite that looks like it is going to become a problem for us, then we call on our good friends in the Air Force, or NOAA has a couple of research airplanes that we can fly right out into the storm and collect the data that is so vital in establishing our warnings.

Finally, as a hurricane would make landfall on the coast, then we would monitor with a coastal radar.

Now, we are looking at the hurricane very well. We are observing it very well. The problem we have is in determining what is going on in the environment around the storm. That is where we have some limitation. Now, if you are going to forecast where the storm has got to go, you have to know what is going on in the environment.

The normal data collection systems that we have today would be very expensive to put over the vast regions of the Atlantic Ocean. Economically this is not feasible, so the only hope we have in the future is through some kind of remote sensing through the eyes of a weather satellite.

We must determine what is going on in the middle part of the atmosphere, the 10,000 to 25,000 foot level, if we are going to improve hurricane forecastings at all.

Now, in terms of the NEXRAD, when a hurricane does get in close to the coastline, we are going to observe it much better with the NEXRAD system, and I think particularly from the standpoint of the inland flooding along rivers. You have that problem, of course, in your own State.

We will be able to have a much better look at what the precipitation potential is with the storm as it crosses the coastline, and I think that that is going to help us tremendously in our river forecasting on the inland areas.

We are also excited about some of the ways of processing data. We desperately need to be able to get this complicated meteorological data into a form that is understandable and then ultimately to the user which is a local government official.

So we are very excited about some of the things that are being proposed. We are anxious to move on in NOAA. I think the progress is going to be slow in terms of a significant improvement in our hurricane forecasting skills, but we are looking forward to utilizing some of the instrumentation and some of the technology that has been proposed here today.

Thank you for the opportunity of sharing with you today.

Senator GORTON. We appreciate your summarizing. We will include your statement as if read.

What happened with Gloria last fall? Did we find out whether or not we had an adequate evacuation plan?

Dr. FRANK. Glorida and others, eight as a matter of fact, named storms came across our coastline last year, and that is the first time that has happened since 1916, so it was a very active hurricane season.

We have been moving forward, I think, very nicely in developing our comprehensive hurricane planning along the coastline. Specifically, now, I am talking about evacuation. Perhaps the most serious decision that has to be made when a hurricane is approaching the coastline is to identify those areas that need to be evacuated to escape the storm surge, essentially.

Now, we started comprehensive evacuation studies in the late 1970s, and we have now essentially completed most of the Gulf Coast except for a very glaring exception, and that is New Orleans. I do not know yet today now long it takes to evacuate that most vulnerable city.

We do know——

Senator GORTON. Or where people go when they evacuate.

Dr. FRANK. In the comprehensive evacuation studies, you have to consider your neighbor when you plan your evacuation because everyone comes off the coast and meets at the inland roadway system.

So we had our first comprehensive evacuation study completed in 1978 on the west coast of Florida, and we now have completed that kind of study in the Galveston Bay area, most of Texas, all of Florida, parts of South Carolina. North Carolina is moving aboard in this area, and we are gradually beginning to move on up into the northeast.

When Gloria went up the northeast, though, last year we did not know how long it would take to evacuate the Jersey coast or Long Island or Rhode Island, places like that.

Senator GORTON. We had a situation there where just a change in a couple of degrees in the direction of the storm had a tremendous impact on what its effect would be, did we not?

Dr. FRANK. Absolutely, and there were three things that happened with Gloria that were extremely fortunate.

Number one, it arrived at low tide.

Number two, the strong part of the storm, the strongest wind, always on the righthand side, stayed offshore from Virginia up to New Jersey, and so it was the central part of Long Island that got devastated by the storm.

Third, even though the storm was accelerating, it was moving slow enough that it began to respond to the cool water and it was beginning to weaken a little bit. If it had been a high tide storm, it would have been a much different story.

Senator GORTON. Are we going to make a great deal of progress in the next decade in hurricane forecasting?

Dr. FRANK. We are going to have to find some way of determining what is happening in the middle part of the atmosphere out over the vast ocean region in order for that to take place, and so maybe through some kind of remote sensing with satellites we will be able to do that.

Senator GORTON. So progress is going to depend on better instrumentation rather than better analysis?

Dr. FRANK. The analysis goes with that. Hurricanes move along in rivers of air just like a block of wood moves along in a river of water.

One big exception in the atmosphere, we do not have river banks, and so the rivers move. Our dilemma in hurricane forecasting is trying to determine what that river is going to do.

The rivers that we are interested in in the tropics often have their origin over the ocean regions, the Atlantic Ocean for example. So we do not know what is going on in the middle part of the atmosphere over the vast regions of the Atlantic Ocean.

We can track clouds with our movies, and it is kind of interesting. In the tropics you have low clouds, so you can say something about what is going on in the lower part of the atmosphere. We have high clouds, where you have jet airplanes, and we can say something about what is going on up there, but we do not have a way of measuring what is going on in the middle part of the atmosphere.

Now, we do have some ways of doing that through the satellite called a Sounder System. Unfortunately, the system that we are using right now is not accurate enough to go ahead and give us the kind of data that we need in the tropical region, so we are looking forward to some improvement in that kind of a system in the future.

Senator GORTON. I take it, then, that you do not buy the sort of hopeless proposition that hurricanes are fundamentally unpredictable?

Dr. FRANK. No, sir.

Senator GORTON. We can develop the knowledge and can develop the system that would make them pretty highly predictable?

Dr. FRANK. I think there is a question of how far we can go in our predicting skills. You mentioned Gloria, and Gloria would be a good example of that. You know, a ten degree movement to the left or a ten degree movement to the right, and that currently is beyond our skills to predict and makes a big difference whether you miss Cape Cod or whether you had the storm coming up inland across Washington, DC and Baltimore or that it took the course that it took.

I do believe that there is an ability to forecast the hurricane, and the better that we can interpret what the flow patterns look like out over these vast regions, I think we could develop skills that would certainly be needed as we look at evacuation times of 20 to 30 hours.

Senator GORTON. Can you tell me a little bit more about the importance of NEXRAD in connection with warnings of inland flooding?

Dr. FRANK. One of the big problems you have, of course, with the hurricane is you do get heavy rains on the inland area. I do not think anyone is really surprised about that. You have three events associated with a hurricane that we worry about. The storm surge is a coastal problem. The winds everybody knows about, but then you can have heavy rains on the inland area, and you can have significant flooding.

As a matter of fact, before Frederick in 1979 with $2.3 billion worth of damage, the costliest hurricane or named storm in this country was Agnes in 1972 where you had tremendous floodings in the Pennsylvania area with $2 billion worth of damage. So you can get significant amounts of flooding back in the inland areas with the rainfall associated with a hurricane.

We believe that the NEXRAD is going to help us to evaluate the amount of moisture and the potential for rainfall of a storm as it approaches the coastline, and then we can put that into our inland flooding forecast.

Senator GORTON. So you believe that going ahead with that is just absolutely vital?

Dr. FRANK. Oh, yes, sir, anything we can do is vital. We have thousands and thousands of lives exposed out on that coastline, and so we need to be moving forward in this nation.

Senator GORTON. How much money does NOAA spend on reconnaisance flights in the hurricanes? They were very, very much in the news during Gloria last fall, but what kind of information do those flights provide that you cannot get any other way?

Dr. FRANK. Let me talk about the information, and then I will talk about—it is hard to say how much money specifically each year because it depends on how many storms there are.

We reimburse the Department of Defense to the tune of about $2,500 an hour when an airplane is flying, so if we take a normal ten-hour mission, we are talking about $25,000. Then it just depends on whether you have a very active hurricane season or whether you have a very quiet season how many dollars that you spend. We are prepared to spend up into the millions, though, if we have to.

Specifically, what does a reconnaisance aircraft tell you that you cannot tell from satellites? Maybe I can use an analogy here. I think we are in somewhat of an energy crisis in the world today, and there is a shortage of oil and someday we are going to have to pay the price.

So if we would create a little scenario where I would ask you this question, if we have a cold winter day how many logs are being burned in the fires in all the places over the midwest where we have fireplaces.

One way you could attack that problem would be to take an airplane and fly around and see where the smoke was coming out of the fireplaces. If you knew something about the wind, you might be able to estimate how many logs are being burned with the size of the smoke plume. If you really wanted to know how many logs were being burned, once you spotted the fire then you land the airplane and go in and count the logs.

That is what the aircraft does for us. The satellite spots the potential fires, in this case the hurricanes, and then the reconnaisance airplane flies right down through the middle and tells us what kind of energy is being consumed there. That is what is vital when you get to the warning stage.

Senator GORTON. Dr. Frank, I want to thank you. You are a marvelously candid and refreshing witness. We enjoyed having you with us, and you are a very good advertisement for the service you provide.

Dr. FRANK. Thank you. I appreciate it.

Dr. CALIO. Excuse me, Mr. Chairman. I would like to make a comment. On this Monday Dr. Frank will be recognized for his leadership at the National Hurricane Center and for his contribution to the Nation as a civil servant. He will be receiving the meritorious Presidential rank for his service over the past years.

Senator GORTON. I am delighted to hear that. and I can understand why and add my congratulations to yours and that formal recognition.

[The statement follows:]

STATEMENT OF NEIL FRANK, DIRECTOR, NATIONAL HURRICANE CENTER, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, DEPARTMENT OF COMMERCE

Mr. Chairman and members of the Subcommittee: Last year the American Meteorological Society became alarmed at the magnitude of the escalating hurricane problem and asked me to draft a "Statement of Concern". I have taken the liberty of using this statement in the preparation of my remarks.

We are more vulnerable to hurricanes in the United States now than we have ever been in our history. Millions of people have been attracted to our beautiful coasts, exposing a large population to the threat from hurricanes. The primary concern is that residents of coastal areas that are vulnerable to flooding from hurricane's storm surge may not have enough time to evacuate. In certain locations and meteorological circumstances, an evacuation cannot be completed within the warning time that hurricane forecasters can realistically provide.

During the past decade a number of comprehensive evacuation studies have been completed and the results are alarming. It would take 20 to 30 hours to evacuate some of the most hurricane-prone locations, including the Galveston Bay area, Tampa Bay area, the southwest Florida coast, the Florida Keys, and the southeast Florida coast. Evacuation times for Corpus Cristi, Texas, Beaumont, and Charleston, South Carolina, approach 15 hours. We do not know the time required to evacuate our most vulnerable city, New Orleans, not the coastal islands of New Jersey, a mecca for hundreds of thousands of summertime vacationers. Studies of these areas have yet to be completed, but it is estimated that their evacuation times are similar to that for the Galveston Bay area.

Traditionally, the goal of the National Hurricane Center has been to provide 12 hours of daylight warning time for evacuation. Obviously, the time required to evacuate many coastal areas far exceeds the lead time of our warnings. If we attempt to provide the longer warning lead times that are compatible with evacuation studies, excessive evacuations will occur because of deficiencies in hurricane forecasting skills for these extended periods. Consider the problem that arises when an intense hurricane threatens an area that requires 24 hours to evacuate. If a perfect forecast could be made, the length of the coastal region that required evacuation would normally be less than 100 miles. However, the average error in predicting the position of a hurricane 24 hours in advance is slightly more than 100 miles. To provide for this uncertainty in the forecast track, approximately 300 miles of coast would have to be evacuated. Consequently, two-thirds of those who evacuated would have done so unnecessarily. Stated another way—for every three times evacuation is advised, only once will it prove necessary. This raises the issue of credibility. How many times will people evacuate unnecessarily before they lose faith in the warnings and ignore the advice to evacuate?

The hurricane warning problem is compounded by two serious misconceptions. First, coastal residents find it difficult to believe that evacuation times are as great as indicated by comprehensive studies. According to a survey of 300 coastal residents, which was conducted a few years ago, the median estimated time to evacuate the Sarasota, Florida coastal area was one and one-half hours. In reality, detailed analysis reveals that it would take 16 hours to move threatened residents to safety.

The second prevailing misconception is that forecasts are much more accurate than they are. This misconception is being inadvertently fostered, in part, by the impressive display of weather information shown daily on television. Viewers are dazzled by color animations of satellite and radar images that are accompanied by computer-generated weather maps marching across their screens. There is a perception that technology has resulted in much more accurate forecasts today than those of a decade or two ago. In fact, the atmosphere is observed in much greater detail than ever before, and computers produce more accurate descriptions of certain atmospheric features. However, the improvement in hurricane forecasts falls far short of the public's perception.

The preceding portion of my testimony has been an attempt to convey to you the magnitude of the hurricane problem in this nation. Now, I would like to focus on specific items of technological development and associated programs of NOAA and the National Weather Service which will improve upon the hurricane forecast and warning program. Let us first consider the satellite.

The geosynchronous satellite is our first line of defense the hurricane threat. This is the means by which we continuously monitor the vast tropical and sub-tropical regions of our hemisphere. Without this capability, we would need a huge fleet of aircraft to monitor the oceanic areas of interest and would still likely miss significant storm developments. Indeed, prior to the days of satellite, the U.S. Air Force and U.S. Navy flew standard reconnaissance flights almost every day over portions of the Gulf of Mexico, Caribbean Sea, and North Atlantic Ocean. When some potential area of development was noted, additional flights were concentrated on those areas. With the satellite, we are able to be much more selective in the utilization of the very reconnaissance aircraft resources. We can pinpoint where and when we need to send aircraft to obtain more quantitative data in the core of hurricanes or their precursors. As such, these systems are quite complementary.

Is there a reasonable solution to the hurricane problem? First, it is unlikely that major scientific and/or technological breakthroughs in the field of hurricane forecasting will solve this problem alone. If there is a solution, it would seem to be a combination of better community planning and technological improvements. What do we need to make major improvements in hurricane forecasts? The geosynchronous satellite has provided considerable information on flow patterns at upper and lower levels in the troposphere, but little detail in the mid troposphere (10,000 to 20,000 feet). Our studies to date tell us that this is the most critical region for obtaining improvements in hurricane track forecasts. We are in the process of testing sounder data from satellites (VAS), but whether these sensors provide data of sufficient accuracy for the sensitive tropical atmosphere remains to be seen. However, the only realistic hope of obtaining such information over the oceanic areas would seem to be from satellites and we expect to make further improvements in this area along with advancements in numerical modeling and analysis techniques.

The second line of defense against the hurricane threat is reconnaissance aircraft. The Improved Weather Reconnaissance System (IWRS) being implemented upon U.S. Air Force aircraft is taking advantage of developments from NOAA's research aircraft. These systems provide detailed information on the wind fields and strength of the hurricane via a satellite data link to the National Hurricane Center for use in the critical warning periods. This info is used to supplement satellite observations which are limited in their quantitative ability to determine hurricane core structure and strength as well as center position when an "eye" is not present. These resources are used selectively with limited use over the open waters and increased coverage during critical warning periods.

Finally, when a hurricane approaches the coast of the continental U.S. the coastal NWS radar network comes into play. These systems as well as coastal surface and buoy observations are used to "fine tune" the warnings in terms of timing and last minute deviations along the coast. All of these observations are supplementary and complementary to the satellite and reconnaissance aircraft observations mentioned earlier. The limited effective range of these radar systems (less than 200 miles) usually means that warnings will already be in place prior to the center of the hurricane being observed on the radar. However, for systems developing near, or moving nearly parallel to, or stalling near the coast (such as hurricane Elena off the Florida west coast) this radar network can become primary in the warning process.

The addition of the doppler capability of NEXRAD would be of special importance in these situations or other rapidly developing situations such as a storm that surprised us along the Florida west coast in 1982. Coastal residents in that case were shocked to awaken to early morning warnings and winds of 60 mph and water rises of five feet. In addition, reconnaissance aircraft do not fly in hurricanes over land. The doppler capabilities will provide much needed information on changes of wind fields over land with height which hopefully will permit us to make more refined warnings in the future. In addition of the wind and storm surge problems associated with hurricanes is inland flooding due to heavy rainfall. The NEXRAD system should aid in improving rainfall forecasts and permit better warnings for inland river flooding such as that of hurricane Agnes in 1972 which caused major flooding from North Carolina through Pennsylvania and New York with loss of 122 lives and $2 billion in damage.

The greatest killer in the hurricane is the storm surge. Generally it is for this element that communities need to be evacuated. Evacuation studies are fundamental to protection of lives from the hurricane threat. These evacuations are very expensive and can be time-consuming as indicated in my opening statement. They rely upon estimations of what areas will be inundated under specified hurricane situations. A storm surge model called SLOSH has been adapted to 25 key basins along our coastlines from Texas to Massachusetts to determine expected levels and areas of inundation. Nearly one half of these basins have had the storm surge simulations completed. Evacuation studies in progress for these cases include portions of Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware and New Jersey. Studies are expected to begin soon in Rhode Island, Massachusetts and Apalachicola, Florida. The remaining basins from this group are expected to be completed over the next few years.

To improve the hurricane forecast and warning process, AWIPS-90 is being developed to access, process and analyze the large quantities and numerous sources of data and then to provide products to users in order to optimize desired responses. Critical meteorological information is required by local, state and federal governmental officials and perhaps private industry can be displayed graphically and either accessed or transmitted to users. For example, warning areas, storm surge simulations of expected coastal flooding, expected rainfall, maps of probabilities, etc., would be generated and made accessible to users. Providing a uniform product for these users should then minimize chances of confusion and result in a more effective warning and evacuation process.

This statement is not intended to be an argument for or against coastal development. It is a plea for responsible planning for the protection of the lives and property of U.S. citizens. If we do not move forward quickly in seeking solutions to the hurricane problem, we will pay a severe price. The price may be thousands of lives. The meteorological instrumentation, technology and research currently being proposed in the President's are excellent steps in the right direction in our efforts to improve the hurricane forecasting and warning process. Hopefully, similar efforts will be made on the part of community planners so that we can work together to provide an effective total system for the protection of the more than 40 million residents of our hurricane-prone coastal areas.

Senator GORTON. Our next witnes will be Colonel Ramsay. The Chair is going to have to take a very brief recess of 3 to 5 minutes, but if you will come up here, Colonel, and get ready we will be right back.

[Brief recess.]

Colonel Ramsay, I apologize for the delay, but we are now delighted to hear from you.

STATEMENT OF COL. ALLAN C. RAMSAY, CHAIRMAN, JOINT ENVIRONMENTAL SATELLITE COORDINATING GROUP, OFFICE OF THE UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

Colonel RAMSAY. Good morning, Mr. Chairman.

It is a pleasure for me to be here and give you a DOD perspective on the NOAA satellite programs.

I have submitted a written statement for the record.

Senator GORTON. It will be included in the record.

Colonel RAMSAY. I do have a few comments I would like to make that are found in that statement.

First of all, my statements will be entirely unclassified. If any of the answers to your questions will lead us up that path, I will ask for an executive session and be happy to give you complete answers.

We were asked to address three specific issues in regard to the satellite program, but I would like to give you a few general remarks to lead in. First of all, the fact is that the Department of Defense and NOAA have cooperated very carefully in our polar orbiting programs for many, many years. Our polar satellite programs are superficially similar but they are not identical.

They were designed and they are operated in response to different requirements. They are not interchangeable, and I would like to make that clear. The systems are complementary, and the data exchanged between the two systems is total, so we have a complete and rapid data exchange.

Senator GORTON. You said that exchange is total?

Colonel RAMSAY. Is total. Yes, we withhold no data. We have relied for many years on NOAA to distribute DOD environmental data to the civil, that is, the national and international communities, and we will continue to provide all of our data to NOAA to distribute to the world.

We do make significant use, that is, the DOD does make significant use of data obtained from the NOAA satellites. I would like to commend to you a report that was written by NOAA with DOD assistance that describes in great detail our requirements for NOAA data and our use of that data, and your staff does have that.

We emphasize that all of the NOAA satellite data, the soundings, the visible and infrared imagery, and the space environmental observations are used primarily as backup and supplemental information to that that we get from the Defense Meteorological Satellite Program, the DMSP.

The first specific question we were asked was the effect of the elimination of one NOAA polar orbiter. I would also like to commend to you another report prepared by the GAO issued in March of 1986, which is an excellent summary of exactly that impact, and discusses it in great detail.

In the context of environmental support across the entire DOD, the loss of one civil polar orbiter would have minimal impact on the majority of defense missions.

Note that the DMSP fully meets our highest priority requirements, and some fraction of the lower priority requirements, but not all. The NOAA satellites provide backup and supplemental support for our highest priority requirements, and they provide additional support to our lower priority requirements.

Would we feel the loss of a NOAA satellite? Yes, we would. Would we feel it enough to launch a replacement? No, we would not.

The second question we were asked was the effect of convergence of the civil and military polar orbiting programs. We are aware that that has been discussed since, I believe, since 1972, and we are also aware that the General Accounting Office may be recommending it again in the near future.

We have not attempted to establish a formal position because it is a possible recommendation. We have worked closely with the GAO over the last year, so we are aware of some of the issues. We find little reason to change the DOD position that was stated first in 1979.

Specifically, the DOD prefers the retention of separate civil and military programs, in recognition of the fundamental programmatic differences in the two programs. We have unique and critical requirements for security, survivability, launch responsiveness, and flexiblity of orbit selection: that is, requirements that are unique to the DOD.

If convergence were directed, we believe it would be technically feasible, but it would be viable only by augmentation of the defense program to support civil needs while retaining DOD management.

Senator GORTON. Would it really save any money under those circumstances?

Colonel RAMSAY. I have not seen any studies that would give us money savings, and I would say that is questionable. The unique requirements that we have, again, security survivability, et cetera, place a financial burden on the system that it may not be appropriate to lay on the civil system. Those numbers, as far as I know, have not been documented.

The timing of any directed convergence is of some concern. If convergence is shown to be or can be shown to be acceptable and cost effective, we would urge that it be undertaken as a coherent and a long-range program. That is, we do not want to rush into it.

The Department of Defense is now embarking on a comprehensive design effort for the DMSP follow-on system which will be known as Block 6. It is scheduled for flight in the late 1990s. We are beginning planning today. We believe that the incorporation of sensors and other systems to satisfy civil needs could best be accomplished on that follow-on system.

And the last issue that we were asked to comment on was the potential impact of the coexistence of Federal sensors and private land remote sensing instruments on a single platform.

We have not seen this specific concept in detail, so we cannot provide detailed comments on it. As you have learned this morning, it is not an administration position. However, we would endorse initiatives that would increase the availability of LANDSAT and meteorological satellite data in a generic sense.

In summary, I want to reemphasize the long-term cooperation and the mutually supportive arrangement that has existed between NOAA and the Department of Defense. The unique operational requirements which drive the two systems have been best served by designing and operating the programs separately with free and full exchange of data.

That concludes my statement, sir, and I would be happy to take any questions.

Senator GORTON. On that last subject, have there been instances in recent years when a DMSP has not had two functioning satellites, and has been more dependent as a consequence on NOAA's data?

Colonel RAMSAY. Yes, sir, there have. There was a period in the early eighties when the DMSP had no fully operational satellites in orbit, and relied entirely on the civil polar orbiters, and by the way, received great cooperation in the scheduling of the transmissions of those satellites.

Senator GORTON. If the Defense Department were directed to take over NOAA's role in polar orbiting satellites, would it have to abandon some instruments which NOAA is now using?

Colonel RAMSAY. Again, it depends on timing. Our current platforms simply cannot handle the current NOAA responsibilities. We have neither the power nor the space for the sensors. If the convergence were directed over a long term, yes, it would be technically possible to design a new system that I believe could meet all the requirements.

Senator GORTON. But that, of course, would be costly. It would require new design and considerable lead time.

Colonel RAMSAY. Yes, considerable lead time. I think the cost could be minimized if those requirements were levied early and the follow-on system were designed to meet—to fly all of those sensors.

Senator GORTON. You spoke of one set of your plans which cannot be implemented until the late 1990s. Now, looking at that kind of—that far into the future or further in the future, does DOD envisage planning at all for replacing what we might call satellite buses with serviceable platforms?

Colonel RAMSAY. It is not a part of a definite program at this time. The follow-on system will be designed to be shuttle compatible and expendable vehicle compatible. So if that concept is identified in our planning as cost effective, I believe we would certainly go in that direction, but that is not a part of our program at this time.

Senator GORTON. Colonel, thank you. I think we may have a few other questions, which we will submit in writing. I appreciate your candor and directness.

Colonel RAMSAY. Thank you, Mr. Chairman.

[The statement follows:]

STATEMENT OF COL. ALLAN C. RAMSAY, CHAIRMAN, JOINT ENVIRONMENTAL SATELLITE COORDINATING GROUP, OFFICE OF THE UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

Mr. Chairman and Members of the Committee: It is a pleasure for me to appear before you this morning to provide a perspective on various aspects of the NOAA polar-orbiting satellite programs. I am Colonel Allan C. Ramsay, from the Office of the Under Secretary of Defense for Research and Engineering. My statements are entirely unclassified; if answers to any of your questions involve classified information, I will so indicate, and will be happy to provide complete and detailed answers in a secure environment.

We have been asked to address three specific issues:

First, the potential effects of the elimination of one of NOAA's polar-orbiting satellites;

Second, the potential effects of the "convergence" of the civil and military polaorbiting satellite programs; and third, the potential effects of placing federal meteorological instruments on the private LANDSAT platform.

It would be appropriate to begin with a brief statement emphasizing the close and mutually beneficial relationship that has existed between the Department of Defense and NOAA satellite programs for many years. The civil and military polar-orbiting satellite programs are superficially similar, yet are carefully designed and operated in response to markedly different requirements; the hardware, software, and support systems that make up the civil and military programs are NOT interchangeable. The systems are complementary, and the data exchange between the two programs is complete. The DoD has relied for years on NOAA to distribute our data to the U.S. and international civil communities. We will continue to provide NOAA unrestricted access to our unclassified data, and we will continue to rely on NOAA to disseminate those data in accordance with national and international responsibilities.

The military services make significant use of data obtained from the NOAA satellites. A complete and detailed description of the full spectrum of DoD uses of satellite data is presented in NOAA's Envirosat-2000 Report, prepared jointly by NOAA and the Department of Defense, entitled Comparison of the Defense Meteorological Satellite Program (DMSP) and the NOAA Polar-orbiting Operational Environmental Satellite (POES) Program, published in October 1985.

We emphasize that NOAA satellite data—atmospheric soundings, visible and infrared imagery, and space-environmental observations—are used primarily as backup or supplemental information to that provided by the Defense Meteorological Satellite Program (DMSP). NOAA data are used at the Air Force Gobal Weather Central, Omaha, Nebraska; the Navy Fleet Numerical Oceanography Center, Monterey, California; the joint NOAA/Navy Space Environment Services Center at Boulder, Colorado; and at tactical terminals on land and at sea.

EFFECT OF ELIMINATION OF ONE NOAA POLAR ORBITER

The effect of the loss of one NOAA satellite—presumably the morning satellite—was the subject of a General Accounting Office report issued in March 1986. This report (Weather Satellites—User Views of the Consequences of Eliminating a Civilian Polar-Orbiter), was prepared for the House of Representatives Subcommittee on Natural Resources, Agriculture Research, and Environment, Committee on Science and Technology, and involved an extensive series of visits and interviews with the users of NOAA satellite data throughout the DoD (and other agencies). We consider the report to be, overall, a complete, factual, and accurate summary of the effect of the elimination of one civil polar orbiter—we commend it to you.

In the broad context of environmental support across the entire DoD, the loss of one civil polar orbiter would have minimal impact on the majority of DoD activities. Note that the DMSP fully meets the highest priority DoD requirements, and some fraction of the lower-priority needs. The NOAA satellites provide back-up and supplemental support to the DoD's highest-priority requirements, and they provide additional—(a few cases, the only)—satellite data for another fraction of lower-priority requirements.

Would the DoD feel the loss of one NOAA satellite? Certainly! Would the DoD feel the loss enough to launch a replacement? No, we would not.

EFFECT OF CONVERGENCE OF THE CIVIL AND MILITARY POLAR-ORBITING SATELLITES PROGRAMS

The concept of convergence of the polar-orbiting systems has been re-visited a number of times since the early 1970's. Recommendations for convergence have brought the civil and military programs closer together through the use of common basic spacecraft components and especially through closely-coordinated ground-processing and data-distribution arrangements. A formal agreement for shared satellite-data-processing responsibilities among the three major processing centers (NOAA, Navy, and Air Force) is in effect, and all three agencies are working toward full implementation in the late 1980's. When fully operational, NOAA will assume national responsibility for processing and analysis of atmospheric sounding data from both civil and military satellites, the Navy will assume national responsibility for processing and analysis of oceanographic data from both satellite systems, and the Air Force will assume responsibility for processing and analysis of visible and infrared cloud imagery from both systems. The agreement provides for rapid and complete exchange of data among the three agencies and for dissemination of the data to national and international users through NOAA. We believe that the present satellite hardware configuration and the closely-coordinated ground processing systems represent the optimum degree of convergence possible at this time.

We are aware of a possible recommendation to be made by the General Accounting Office to "converge" the current civil and military systems into a single national system. We have not attempted to establish a formal position on a "possible" recommendation, and will need to consider such a recommendation in some detail before a position can be established. We have, however, worked closely with the GAO over the past year in their review of the DMSP; at present we find little reason to change the DoD position adopted in 1979.

Specifically, the DoD prefers the retention of separate civil and military programs in recognition of the fundamental programmatic differences between the systems. The DoD has demanding and critical systems requirements for security, survivability, launch responsiveness, and flexibility of orbit selection. These DoD-unique programmatic requirements place additional systems-design and financial burdens on the military program which may be inappropriate to carry over to a civil component of a converged system.

However, if convergence were directed, we believe that it would be functionally feasible, but would be viable only by augmentation of the DMSP to support civil needs, while retaining DoD management. Among the many issues that would have to be addressed would be the timing of the convergence movement, the proper budgetary arrangements of a converged system, and a detailed examination of the near-term and long-term fiscal impacts (for example, perceived long-term savings of a converged system may be more than offset by significant near-term transition costs required for the DoD to absorb portions of the civil mission).

The timing of any directed convergence program is of great concern. It is clear that the current DMSP cannot satisfy the full spectrum of civil responsibilities. Current and programmed DMSP space platforms do not have adequate space or power to incorporate additional civil payloads. Direction to "converge" in the short term would require either eliminating DoD operational payloads or making a significant (and possibly high-risk) change in spacecraft design. If convergence is ultimately shown to be an acceptable and cost-effective action, we would urge that it be undertaken as a coherent and coordinated long-range program. The Department of Defense is now embarking on a comprehensive design effort for the follow-on DMSP "Block 6" satellite system, scheduled for flight in the late 1990's. We believe that the incorporation of sensors and other systems to satisfy civil needs could be accomplished on that follow-on system—to attempt to do so before that time would be significantly more difficult and could be very costly.

POTENTIAL IMPACT OF THE COEXISTENCE OF FEDERAL SENSORS AND PRIVATE LAND-REMOTE SENSING INSTRUMENTS ON A SINGLE PLATFORM

We have not examined this specific concept in great detail, and cannot at this time comment on potential impact. In general, however, the Department of Defense would endorse initiatives which increase the availability of both LANDSAT and meteorological satellite data. Protection of national security interests for coexistent systems has been considered, and we are confident that they can be accommodated through modification of existing contracts or development of new contracts.

SUMMARY

In summary, let me re-emphasize the long-term cooperative, mutually supportive, and highly successful relationship between the separate civil and military satellite programs. The agency-unique operational requirements which drive the two systems have been best satisfied by designing and operating the programs separately, with free and full exchange of data.

Senator GORTON. Mr. Williams, EOSAT.

You are welcome back again as well, and you are very much a part of this hearing today, so we are anxious to hear from you.

STATEMENT OF C. P. WILLIAMS, PRESIDENT, EARTH OBSERVATION SATELLITE COMPANY

Mr. WILLIAMS. Thank you, Mr. Chairman.

I have a brief written statement which has been submitted for the record, but I would like to make a few comments.

Senator GORTON. We will include it in the record.

Mr. WILLIAMS. I woud like to make a few brief comments just as introductory and reminder remarks in support of that.

I am pleased to be here to testify on behalf of EOSAT or Earth Observation Satellite Company. We at EOSAT are extremely distressed to learn of the deletion of the budget line item in fiscal year 1987. EOSAT and others in the industry, along with NOAA, NASA, and the State Department have spent the last few years——

Senator GORTON. Mr. Williams, if you do not mind my interrupting, the Chairman, with all the time he has spent on that in the last year, shares that view.

Mr. WILLIAMS. In response to the basic questions, we did respond to each and every question in the written statement, and I will extend those answers for you as part of the extension of the additional testimony, but we do believe that there has been a viable transition from the Government to the private sector as part of the effort that was established last year. We believe that this position was mandated by the Congress, and we believe that the transition, which involved both international and domestic activity, is necessary and is of a national priority.

A number of things that have been indicated, and were indicated by Dr. Calio this morning, evaluation of alternate platform concepts and also alternate mission profiles are possibilities as far as extending the LANDSAT effort and combining it with other programs. By the same token, we believe that the LANDSAT mission per se is still of national priority and international significance. We believe that it will affect a number of people, a number of countries throughout the world.

We are dealing right now with about 25 countries, and LANDSAT as a data element has been used and identified by over 10,000 users throughout the world. We feel it is an important issue, and for that reason we ask Congress to reconsider the full impact, both domestically and internationally, of the line item deletion.

We feel that the elimination of the hardware development could be a total death knell for the LANDSAT program in the United States in many different ways, and we feel that that will affect not only the United States industry per se, but it will also affect the policy of the United States as promulgated by the prior administrations and the current administration.

With that, we feel it appropriate that a complete review of the line item deletion be made, and we ask that the Congress reconsider the full impact, and request reinstatement of that line item.

Thank you. I would be happy to answer questions.

Senator GORTON. Mr. Williams, why don't you bring the Committee up to date on your progress since you assumed operation of data marketing of the current LANDSAT system? How have you progressed in marketing the program and the like?

Mr. WILLIAMS. In brief summary, as far as our progress to date, as you are well aware, the contract was executed in September 1985. At that point in time, we initiated the transition and takeover of the LANDSAT IV and V operational systems, and takeover of the operation and management of the activity at the Goddard Space Flight Center for current weather satellites—I am sorry—LANDSAT satellites. Let me get the subject correct here.

The land remote sensing mission relative to LANDSAT V, which is the primary satellite that is flying right now at this point in time is 100 percent functional and operational. Some of the elements that we have looked at and some of the rough probability estimates that we have—estimates that we have made indicate that LANDSAT V will fly longer than its expected design life.

As Dr. Calio indicated, there is no way to tell explicitly how long any satellite would fly. The probability estimates have indicated that it will fly considerably longer than its current projected design life.

As far as the EOSAT effort in marketing, we have extended and implemented a complete marketing force. We have developed a worldwide credibility and presence, if you will, in more than 25 countries that we deal with both in ground station activity and in data user activity.

There are basically 11 foreign ground stations operating today which we are coordinating with and cooperating with on a day-to-day basis along with NOAA. NOAA does retain oversight and management of the system. We have a supportive, qualitative, and cooperative effort with them in meeting with the ground stations, working out details of downlinking of data in the foreign countries, and also implemention of new product schedules.

We have, to the best of my knowledge complied completely with the intent of Public Law 98-365, and at the present time we are extending that development into the hardware development phase of the overall program basically to support LANDSAT VI and VII knowledge, and support the launch of the next satellite in 1989.

I believe that we are progressing on a reasonably viable course. There are some minor elements which are slightly behind schedule due to the transition from the government to the private sector which you are well aware of. That has to do with the Trade Secrets Act and the acceptance primarily by each and every end-item user in order to enforce agreement and concurrence with the law.

But to that extent, we feel very comfortable with the position that we have right now. There are well over 700 Trade Secret Agreements signed with major users in companies throughout the world. We feel that we are in a very viable position and a very good position to proceed on.

Senator GORTON. How are you going to be affected by SPOT competition?

Mr. WILLIAMS. The competition from SPOT-image, as such, has always been considered as part of our overall marketing plan. But by the same token, if the current program in itself is not extended beyond the current fiscal year 1986 budget, there will be a great disability felt by EOSAT in its marketing of the data, and also in its organization and/or implementation with foreign users.

Most of the money spent by the foreign users are based upon data continuity; long-term data use. If they are unable to see data continuity or long-term use of the data for their own systems, they are not going to invest in the hardware to support LANDSAT data. In that respect, SPOT-IMAGE, which is a heavily subsidized French system, would have a great advantage over any LANDSAT data sold in the rest of the world.

Senator GORTON. But on the other hand if we go forward with the contract you feel SPOT would not have that tremendous advantage?

Mr. WILLIAMS. No they would not. We feel comfortable with the implementation of the LANDSAT data we have, and with the capability of the thematic mapper as a sensor. There are a number of things the thematic mapper can do because it is a seven band instrument, where SPOT is a three band limited instrument. There are a number of things that it can do in search for instance for hydrocarbons, which was proven by a study financed by EOSAT and reported on just last week. It indicates that one of the principle things that you look for in hydrocarbon initiative or exploration is kaolinite, or the amount of kaolinite in particular rock formations.

The band combinations that are offered by SPOT are unable to discern the amount of kaolinite in rock formations. They simply do not have the spectral range in order to ascertain it. And in that area, in the search for hydrocarbons or oil in particular, it is of critical importance.

So we feel comfortable with the design that we have, and we also feel comfortable that the 15 meter panchromatic band that we are implementing will be directly competitive with the 10-meter SPOT data.

Senator GORTON. Let us go on to the subject of a combination of your system and weather instruments on the Oministar platform. What concerns do you have about sharing the platform with Federal meteorological instruments?

Mr. WILLIAMS. To the best of my knowledge, I do not have any major concerns, other than the possible implementation—or imposition, if you will, if that is correct word—of additional controls which may cause minor changes to the way LANDSAT data is processed and/or distributed. But for the most part, I do not see any major elements—to the extent that we have evaluated it, I do not see any major elements that would affect the basic LANDSAT mission per se, or the actual performance of LANDSAT as a mission.

Senator GORTON. Under the proposal which you have seen, would EOSAT operate the platform?

Mr. WILLIAMS. I am afraid I have not seen the Government's proposal yet, so I could not comment on that. My presumption is that EOSAT would operate the platform in the same mode of operation as we currently operate the LANDSAT mission.

Senator GORTON. Would not that present a violation of the division of Public Law 98-365 which prohibits private operation of weather satellites?

Mr. WILLIAMS. In that context, yes, sir. It would require changes to some extent inPublic Law 98-365, of which there are certain changes under consideration right now.

Senator GORTON. Do you have reasonable assurance that the Federal Government would be willing and able to service an Oministar platform in the event that one of your instruments failed?

Mr. WILLIAMS. I'm sorry? Do you mean can we provide reasonable assurance to the Government? I believe that as far as the design of the platform is concerned right now, the implementation to the extent that we have evaluated it indicates that we would be able to service the platform in an appropriate mode, and in an appropriate time frame.

Senator GORTON. A couple of years ago, when Congress was considering legislation to authorize the commercialization of LANDSAT, there was a great deal of concern that a data gap after the failure of LANDSAT V would hamper the commercial availability of commercial follow-on systems.

It looks as though that data gap is highly likely now, and of course SPOT has been launched. When will your system be prepared for launch if properly funded, and how important is the fiscal year 1987 funding level to the timing of that launch?

Mr. WILLIAMS. Let me respond to the last portion, and I will work my way back up to the front part of the question. The fiscal year 1987 funding is the key element in the hardware development in order to put LANDSAT VI or the next generation satellite or land remote sensing in orbit earlier than mid-1989.

The window that we are looking at right now as far as the LVI launch profile is from December 1988 to April 1989. Without the fiscal year 1987 funding, it will either be the deathknell of the hardware development or it will extend the hardware development at a much higher cost to some time in the 1990's.

That data gap then becomes untenable as far as the current satellite is concerned. There are ways to keep the current satellite flying—that is LANDSAT V—in a degraded mode and still accept data or utilize data from that particular instrument.

As you are well aware, LANDSAT IV has already flown beyond its current lifetime. It has many problems, but by the same token it is still downlinking MSS data, multi-spectral data, today, and can be used on an eight day revisit cycle for foreign ground stations.

So we have great expectations that, with the current probability estimates, LANDSAT V will fly, even in a degraded mode, into the 1987 and possibly the 1988 time frame. But the basic or bottom line is, without the 1987 funding for the hardware development for the new satellites, I do not believe that we could put a satellite in orbit earlier than mid-1990.

Senator GORTON. You spoke of your unique ability with respect to the exploration for oil and for other minerals. What do you now think your largest market is going to be, non-renewable resources or repeat coverage for renewable resources, like agriculture?

Mr. WILLIAMS. Well, we still believe that some of the market surveys that were performed in 1983, 1984, and again partially in 1985 are still valid. The near-term market per se still will concentrate on those spectral bands that deal primarily in the oil, gas, and mineral exploration area, heavily that exploration area, probably, through the 1987 to 1988 time frame.

Beyond that time frame, we will see a lessening of the exploration activity and probably a direct increase in the renewable resource industry that requires more seasonal coverage. We are serving the agricultural renewable resource industry today.

By the same token, we feel the amount of work that is being done by other organizations, such as the Department of Agriculture, will greatly increase the need and the utilization of that data in the early 1990's.

Senator GORTON. So long-range, it has very considerable potential still as far as you are concerned?

Mr. WILLIAMS. Exactly, yes sir.

Senator GORTON. Mr. Williams, thank you. You are very important to what we are going to be considering in the near future, just as we are to you. We appreciate having had you here today.

Mr. WILLIAMS. Thank you, Mr. Chairman.

[The statement follows:]

STATEMENT OF C.P. WILLIAMS, PRESIDENT, EARTH OBSERVATION SATELLITE CO.

Thank you, Mr. Chairman, and members of the subcommittee: I am pleased to be here to testify on behalf of the Earth Observation Satellite Company. Today, I would like to respond specifically to the questions raised in the chairman's letter of 31 March.

Landsat was transfered to the private sector (EOSAT) in September 1985. This action was taken as a result of the widely held belief both by the administration and the Congress that the technology had matured almost to the point of self sufficiency, and also to reduce the overall cost of Gaovernment involvement. Independent studies jointly commissioned by NOAA, private industry and the Congress Budget Office [1] estimated that the cost to the Federal Government of maintaining and operating the Landsat System for 1985–89 alone would have been $900 million. With operation, management and marketing by private industry, and agreements in 1985 with the administration and the Office of Management and Budget, Government costs and involvement will be less than $400 million from 1985 through 1994.

Internationally, EOSAT accepted and is managing the U.S. Government's commitments and obligations contained in memoranda of understanding (MOU's) with 13 foreign entities for satellite data reception. Their investments, conservatively estimated at a quarter of a billion dollars to date, and their continued involvement are based upon the U.S. administration policy of 1985 promulgating a 10-year program for Landsat. This is a direct extension of the U.S. Government's "open skies" and "non discriminatory access" policies which have been advocated by every administration since Eisenhower, and which this committee has characterized as a "key component of U.S. foreign policy interests."

EOSAT is sincerely distressed to learn of the deletion of the budget line item in FY87. EOSAT and others in industry along with NOAA, NASA and the State Department have spent the last several years rebuilding the U.S. image and credibility in remote sensing throughout the world. Over 10,000 users representing over 80 countries and almost all U.S. Government agencies, use or have used Landsat data. We believe that the Congressional actions taken and support given in 1983 and 1984 which resulted in public law 98–365 mandated commercialization of satellite remote sensing and established a Government commitment to a 10-year program. We also believe that Landsat is a national priority program and an internationally shared resource.

Actions taken by the Congress and the administration in 1985 went a long way toward re-established U.S. commitment to land remote sensing leadership. However, zeroing of the Landsat budget for fiscal 1987 represents a direct reversal of the administration's agreements and commitments to the principles of land remote sensing and a total retreat from the congressional position established in 1984. This will contribute to a lack of confidence in any long term U.S. policy in the eyes of a large number of countries throughout the world.

With respect to the long-life, flexible space platform concept designated "omnistar", EOSAT believes that this concept represents the next generation in satellite platform technology and the future of satellite sensing as we know it today. The platform provides modularity, in-orbit retrievability, refurbishment capability, excess power and payload capacity, and will be able to handle multiple missions and instruments. This increased flexibility and capacity will enable EOSAT to meet its contract obligations to perform the Landsat mission, and in addition provide opportunities for other scientific experiments for Government sponsored or commercial research. "Omnistar" is in the detail design phase of its development and will be used for Landsats 6 and 7. EOSAT plans to fly Landsats 6 and 7 with upgraded instrumentation and integrate other commercial and scientific payloads to optimize the platform capability.

Regarding the question of international competition in remote sensing, EOSAT believes that with the level of support provided in Public Law 98–365, and in the commercialization contract executed last September, our system is capable of competing successfully with existing and proposed foreign systems, such as spot. EOSAT also believes, however, that the reversal in the administration's budget position relative to funding the Landsat commercialization program greatly strengthens the worldwide market position of the heavily subsidized foreign systems such as the spot system, Japanese MOS–1, and European Space Agency ERS–1. Should the current situation continue, we believe that U.S. Government and industry will be forced to rely on foreign powers to supply its data needs and thereby negate its 15-year posi-

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(1) Letter of Report, Director CBO to Chairman, Senate Commerce, Science and Transportation Committee of May 15, 1984.

tion of technological leadership in the peaceful use of outer space, and over $500 million investment in land remote sensing.

In order to maintain the U.S. position in satellite remote sensing, Eosat plans include enhancing the thematic mapper (TM) by adding a 15 meter panchromatic band that will fly on Landsat 6. Technically, we believe that the 15 meter data will be directly competitive to the spot 10-meter data and will support international efforts to improve the quality of mapping world-wide. Since this data will be consistent with previous Landsat data sets in areal coverge and also easily combined with the broad band coverage of the TM, it will have a distinct advantage over the smaller areal coverage and more restricted spectral data sets offered by our French competitor. In addition, new and innovative Landsat ground system techniques and processing currently being designed will allow users to access tailored data sets including new 15-meter resolution multispectral image products that better fit their requirements by providing data not only over small geographic areas but also in formats that are more amendable to the types of analysis systems that are becoming more readily available in today's markets.

In addition to the high resolution band, improved data throughput, and variety of new data products, Eosat also plans to fly tape recorders rather than rely on TDRS communications satellites. The tape recorders will permit us to collect data over any part of the globe. The expanded payload capacity on Landsat 6 utilizing omnistar provides opportunties to fly other land or ocean sensors that would provide important data to other physical science disciplines. To the best of our knowledge, Landsat 6 will offer the only opportunity to collect this type of low and medium resolution data during this decade, and year before it will be available from any foreign competition.

Eosat, in conjunction with NASA, has sponsored a thermal infrared working group (TIRWG) of recognized experts from academia, government and private industry, which recently included its findings. The basic purpose of this groups was to establish parameters for future instrument designs and user applications in infrared satellite sensing for both the extractive and renewable resource communities. Key conclusions imply the need for 4 to 5 bands in the 8 to 12 micron spectral band and a narrowing of ground resolution. A final report is in preparation and will be available in May.

Eosat along with NOAA, NASA, RCA and Hughes have been forging ahead and establishing a viable transition from the Government to the private sector. A significant part of this activity includes visiting more than 25 countries in establishing a U.S. Government/Eosat presence and relationship. Eliminate of the fiscal year 1987 budget for new hardware development will probably sound the death knell for Landsat as a program beyond 1987, land remote sensing as a viable new U.S. industry, U.S. leadership in land remote sensing technology and eliminate most if not all of our international participation.

We ask that Congress consider the full impact both domestically and internationally of the budget deletion, and request reinstatement of the line item.

I would be happy to respond to any questions you may have, either here or in writing.

Senator GORTON. Now we will hear from Dr. VonderHaar and Mr. McCandless.

Doctor, we will start with you.

STATEMENTS OF DR. THOMAS VONDER HAAR, PROFESSOR OF ATMOSPHERIC SCIENCE, COLORADO STATE UNIVERSITY; AND SAMUEL W. MC CANDLESS, JR., PRESIDENT, USER SYSTEMS INC., ON BEHALF OF NATIONAL OCEAN INDUSTRIES ASSOCIATION

Dr. VONDERHAAR. Thank you, Mr. Chairman.

With your permission, I would like to submit my written testimony for the record.

Senator GORTON. It will be included.

Dr. VONDERHAAR. I will answer and address the four questions that you had written me about, and I am going to do that within the context of the research community in the universities and in the government agencies and others. And like any professor, I have to refer you and commend a few documents to you and your staff. I think you have probably seen them all, and some have been mentioned already.

The one on Remote Sensing of the Earth from Space, A Programming Crisis, put out recently by the National Academy of Science's Space Applications Board, is one I have drawn upon. The excellent and I think comprehensive series of reports put out by NOAA on the envirosat series is very good.

I just recently saw S. 2098 discussing a National Space Grant College Program, and I think that is relevant to the testimony as well. We have had some real solid accomplishments in discovering new knowledge using our weather and climate and ocean satellites, and to me that is only one part of the three-part challenge that confronts researchers in this area.

We continue to try to learn more about our atmosphere, and questions' like El Nino and other things have to be addressed with all the tools available, and we use satellites as part of that research program. But of course, you know a lot about the basic missions of NOAA and the operational forecasting missions, and we have heard Neil Frank talk about how satellites are used dfor hurricane forecasting, and over land in particular. We know how they are used with radar to observe severe storms.

There is a lot of research that lies behind those applications that are coming into being every day. And then, Colonel Ramsay has mentioned the DOD program. There is quite a lot of research that has to take place, some of it in universities. A lot of it is unclassified, and it is a little different than the research we have to do to support NOAA.

For example, the Department of Defense is interested in cloud free line of sight. The Strategic Defense Initiative brings with it some research questions about clouds and about forecasting that are not necessarily addressed by NOAA. So we have a three-part challenge in the research community, to try to serve these three different groups.

We have to ensure that our research system to support these different areas is served with the proper amount of space on our satellites for experimentation. If we become complacent after 25 years of our successful satellite program, we are going to lose our position in the international community and we will be effectively "eating our seed corn."

So my response to your questions today will be in this context of the research background. I think, and the Academy report mentions, that one of the ways to make sure that we continue to develop the new things is to have a plan to require 10 or 20 percent or something like that of the instrument carrying capacity of all of the operational satellites to be reserved for experimentation.

Indeed, NOAA does that today to a certain extent, although it has to be negotiated on an individual basis. Neil Frank talked about seeing through the "smoke" in those hurricanes and seeing the "fire." Well, the research community today believes that we have an experiment that, if placed on one of the five new generating satellites, would most likely be able to see the "fire" in the hurricanes and help Neil and his group with the forecast.

It is those types of experiments that we just hope you will remember as you help plan this program. When we put experiments on an operational satellite, it can be done on a non-interference basis with the operations, and that has been demonstrated again on both types of NOAA satellites and to a certain extent on the DOD satellites.

We talked about international cooperation in the climate area, and indeed we have an example going on right today where the United States, by directing a very small part of its effort with its geostationary and polar program to the International Cloud Climatology Project, allows its satellites to contribute to a data set that is being gathered by the European Space Agency, the Japanese Meteorological Service, and hopefully even the Indians with their new satellite.

So there is good international cooperation for research, but we have to keep the experiments going. Of course, there are a lot of cross-connections between NOAA's data and the NASA activities, and it is important to emphasize that research experiments on operational satellites only complement, they do not replace, the special satellites that NASA prepares.

I would like to summarize this section by saying that we desperately need to keep in mind the fact that we must have experimental space on the satellites to ensure the vitality of the future in the environmental program. And this Space Grant College Program, the bill which has just been introduced, might be a way and probably should be considered as a means to help solve that problem.

Now, regarding the impact of potential changes in NOAA's program, after 25 years of a successful program it is not surprising that there are some new and innovative ideas, and I think NOAA should be commended for coming to you with these new ideas.

The rapid transition into the shuttle era means that opportunities for change are perhaps accelerated, and we are taking advantage of that. I do oppose the elimination of one of the polar orbiter satellites, simply because, as I mentioned, the carrying capacity of our present satellites is not adequate for the number of research experiments that should be there.

And I really endorse the GAO report, which I read just a few days ago, that stated that all of the users are concerned at the risk that would be involved if we were down to a one satellite program.

And now, on convergence, again, as Colonel Ramsay mentioned, that is a question that has been asked quite a few times. It does seem to me that, because of the requirements, the technical requirements, that some convergence is certainly feasible and it is certainly possible that three satellites might be able to serve where four are presently used.

However, I would like to see the fourth satellite retained in the program so that research opportunities would be possible to help NOAA and the DOD programs. I have recently been very pleased to see an increasing interest by DOD scientists in using data from a geostationary satellite. I believe there is a role for a dedicated DOD environmental geostationary satellite, and maybe that will come out of their new planning exercise that they talk about.

Like everyone else here, we really do not have enough information about Omnistar to make intelligent comments. We too are looking forward to seeing the proposal. We hope it has plenty of room for research experiments, and I do not see any fundamental technical problem with putting the Federal meteorological and private land remote sensing instruments on the same satellite.

Now, the last question you addressed to me, Senator, was to talk about NOAA's general role in providing data to the academic community and to the private sector. I think NOAA has to be commended for the excellent job they have done in broadcasting their satellite data, not only across the United States but internationally.

For many years, NOAA has been using direct readout and satellite communications, long before such communications were popular and commonplace in our daily lives. I think there is room for improvement, though, in just the way they have set up the exchange of data, the full exchange of data between the Navy and the Air Force centers and NESDOS.

I believe that same mode of operation could be used to get the data at least out to the research community. So I suggest a broadcast link that would have even more of the satellite data, so scientists at the University of Washington who do research in this area, at Colorado State where I am, at Miami, at Woods Hole, in Texas, in California, Hawaii, all across the United States, could receive satellite data for research, training.

We train some of the people that work in NOAA. Our students go out into NOAA, into the forecast shops, and we need the data for training as well as for research.

There are a lot of bits, millions of bits of data coming down every second, and satellite communication is really the way to go.

Well, in summary, I believe that NOAA should be commended for the innovative ideas that it is bringing forward. I think NOAA is doing a good job. NASA is funding some experiments on NOAA operational satellites. I think that NOAA should maintain the two polar orbiters and consider convergence of both the polar and perhaps geostationary with the Department of Defense.

And I really believe there are ways to unclog the pipeline of data to get it out now and to get it used for many more useful purposes.

Thank you very much, Mr. Chairman, and I will be happy to answer any questions, either now or in writing later.

[The statement follows:]

STATEMENT OF DR. THOMAS H. VONDERHAAR, PROFESSOR OF ATMOSPHERIC SCIENCE, COLORADO STATE UNIVERSITY

1. BACKGROUND

Mr. Chairman and members of the subcommittee, my name is Thomas H. VonderHaar and I reside at 3501 Shiloh Drive in Fort Collins, Colorado. I am a Professor of Atmospheric Science and Director of the Cooperative Institute for Research in the Atmosphere at Colorado State University (CSU). As you requested, a brief biographical sketch is included as an attachment to this testimony.

CSU maintains one of the largest university research programs in the area of environmental satellite applications. For fifteen years our group has been actively involved with NASA, NOAA, DOD and private industry scientists and engineers. We not only use the data form, but also provide the conceptual design of instruments and satellites to observe the atmosphere and oceans. I have daily contact with government scientists involved in satellite research including several Air Weather Service officer-students assigned to CSU for graduate study. I have served as chairman of the Committee on Satellites and Aerospace Systems of the American Meteorological Society, served on several National Academy committees and panels, and on the Board of Directors of the University Corporation for Atmospheric Research.

My testimony will deal with basic and applied research in support of the overall environmental satellite program: applications and uses of the data; comments on the effect of potential changes in NOAA's program; and comments on NOAA's general role in providing data to the private sector and the academic community.

As you know, a number of recent documents provide excellent background for my testimony. I refer to the comprehensive series of ENVIROSAT-2000 Reports by NOAA; the Space Applications Board's "Remote Sensing of the Earth from Space: A Program in Crisis" and the very recent Senate Bill S. 2098 to establish a National Space Grant College Program.

2. RESEARCH IN SUPPORT OF THE ENVIRONMENTAL SATELLITE PROGRAM

Success in the 25-year environmental satellite programs of both NOAA and NASA has drawn heavily upon specific research in the university community, in government labs, and in the private sector. In several cases, as at Colorado State University, the collaboration and cooperation in applied research is fostered by colocation of small, government satellite research groups within the university community. This is done through the cooperative institute program of NOAA and by various other mechanisms. As we move into the 1990's, some major research accomplishments have been attained. For example, we have the successful operation for more than a year now of the first small climate research satellite (indeed the first research satellite to be launched; the Space Shuttle), namely the Earth Radiation Budget Satellite (ERBS). It brings us climate information about the interannual variation of the total energy exchange between earth and space, as well as monitoring stratospheric aerosol and gases, etc.

University atmospheric and oceanic science researchers and others doing similar research in government laboratories must face, quite frankly, a threefold purpose. This is because we must use our environmental satellites for (a) the discovery of fundamental new knowledge about the earth—atmosphere system (ranging from upper atmospheric physics through the interface between the atmosphere, the oceans, and land surfaces), (b) basic and applied research that adds to the national effort for the operational meteorological satellite program of NOAA and (c) research for the Department of Defense environmental satellite program. Three times the amount of research must be done by our community than, for example, in the planetary science and astronomy areas.

We must ensure that our research system to support all three objectives and the many users that develop from these three areas will have adequate room for experimentation. If we become complacent after 25 years of a satellite program, we will lose our position in the international community and we will be effectively "eating our seed corn"! The best way to ensure this is a plan that requires 10, 20, or 25 percent of the instrument-carrying capacity of each operational spacecraft to be reserved for experimentation. The experiments on operational spacecraft can be carried on a non-interference basis with the operational mission. We have excellent evidence, for many years on DOD satellites to a certain extent, and also on the NOAA and GOES satellites, that such experiments can be flown. Of course, due to the limited experimental conditions on these operational satellites, these satellites compliment, rather than compete with or replace, the regular program of research carried out from NASA satellites, including the shuttle and free flying satellites in various orbits.

For the 1980's and 1990's we have to think about systems of satellites carrying instruments that underfly one another to give us a fine, long climate record. Not only is satellite replacement a key issue, but to aid scientific research we must have overlap and underlap. We have examples already where we can tie together systems of five or six satellites to provide much better from such a system than any individual satellite can alone can provide. This is happening under the International Satellite Cloud Climatology Project, in which the U.S. is a participant for the amount of only a few million dollars each year, making a major contribution to climate research.

The cross-connections between research using NOAA's data and the NASA activities are evident to all. I believe that NASA should be encouraged and commended for its activities to fund satellite research experiments on NOAA's operational satellites.

The proposed National Space Grant College Program (S.2098) is addressed to NASA for implementation. We desperately need more space on satellites—space shared on NOAA and DOD vehicles as well as space on small and large NASA satellites to insure the vitality of the future environmental satellite program. A number of National Academy Boards and Committees have succinctly raised this concern. The Space Grant College Program should be considered as a means to solve this problem.

3. APPLICATION AND USES OF THE ENVIRONMENTAL SATELLITE PROGRAM DATA

Mr. Chairman, my academic research and teaching duties bring me into contact with a wide variety of users of environmental satellite data. Observations of the ocean and atmosphere from space are used by:

a. Large government research centers such as NOAA and DOD weather, ocean and solar forecast centers.

b. Smaller, focused government user centers such as Severe Storm and Hurricane Forecast Centers.

c. A wide group of "Direct Read-Out" users ranging from private sector groups to high school science classes who require the data in near realtime.

d. Specialized research groups who may obtain very large or very small amounts of data vital to meet their research objectives.

e. Private sector users for inhouse studies or routine use in commerce and business (e.g., transportation, agriculture).

f. Public dissemination users (e.g., TV broadcasters) who normally receive the data from a value-added private sector group.

g. DOD units in support of their missions.

Many examples of beneficial use of the environmental satellite data are included in the Space Applications Board report referenced earlier. I have just completed a Compendium of Lecture Notes on Meteorological Satellites for the World Meteorological Organization of the United Nations. Documents such as these and others by NOAA and NASA trace the history of the environmental satellite program and the many uses of the data for social and economic benefit. It is noteworthy that items on the frontier of satellite research only 10-12 years ago—such as the time lapse geostationary satellite cloud data—are now common on every television weather program *and* used by our citizens in planning their daily business and leisure activities.

4. COMMENTS REGARDING THE IMPACT OF POTENTIAL CHANGES IN NOAA'S SATELLITE PROGRAM

After 25 years of a successful meteorological satellite program it is not surprising that some innovative changes are under consideration. Rapid transition into the Shuttle era also fosters such change. I believe that the recent decision not to commercialize the weather and ocean satellite system was correct because of (a) international agreements for data exchange and (b) the need to retain public sector control over severe storm monitoring and warning.

I oppose the elimination of one of NOAA's polar orbiting satellites because at the present time we have—as I mentioned earlier—a distinct shortage of satellite experiment carrying capacity in our program. We are not presently monitoring the weather, climate and ocean systems with the frequency demanded by our research, business and public sectors. A reduction in NOAA satellites would be a step in the wrong direction and not in the nation's best interest.

Convergence of the NOAA and DMSP polar-orbiting program has been suggested for several years. Certain orbital local-time and height considerations differ when one looks closely at technical mission requirements of the two groups. It is possible that 3 satellites could serve where 4 are presently used. If the 4th could be devoted to research experiments to serve both DOD and NOAA operations we may find a solution to several key present day problems.

I have recently been pleased to see an increasing interest by DOD scientists in the use of geostationary satellite data. In my opinion there are a number of uses of a dedicated DOD environmental geostationary satellite for special peacetime studies and operations and also to support operations in regions of local conflict. Perhaps convergence or cost-savings in this area should be studied as well as in the polar-orbiting area.

As I mentioned earlier the fresh innovations being proposed by NOAA are generally welcomed by the research and user community. The Omnistar ideas (of which I have little information at this time) are another example of this innovation. I will reserve my primary comments on this matter until I have heard testimony from the NOAA leaders. However, I see no fundamental technical reasons to preclude sharing of a satellite by federal meteorological and private land remote sensing instruments. Certain orbital local-time illumination conditions may be a concern but it should not be insurmountable.

5. COMMENTS ON NOAA'S GENERAL ROLE IN PROVIDING ENVIRONMENTAL SATELLITE DATA TO THE PRIVATE SECTOR AND THE ACADEMIC COMMUNITY

NOAA has done an excellent job of developing and maintaining its direct readout/broadcast services. It began using satellite communications long before it became a common feature in our daily lives.

The key to better data service for the academic and research community is to expand the variety and volume of data broadcast via the NOAA geostationary satellites. I suggest a "shared METSAT" link to the research community. This should provide a vast improvement and perhaps cost savings over the present research data distribution system. At present many users are unhappy with the clogged channels in environmental satellite data distribution. At present the high costs, time delays and resulting difficulties in solving user problems highlight a special problem in the environmental satellite program.

Users of all kinds are ready to receive more and better satellite data via satellite communications. NOAA budgets should be increased in this area.

6. SUMMARY

This is a summary of testimony presented by Professor Thomas H. VonderHaar of Colorado State University to the Senate Subcommittee on Science, Technology and Space on April 15, 1986.

There are a wide variety of uses of weather and ocean observations from satellites. Research in universities and elsewhere must support the triple role of environmental satellites, namely to discover new knowledge about the ocean and climate; to assist the operational satellite program of NOAA; and to support the operational satellite program of the DOD. A presentday shortage of space on satellites for new experiments will inhibit development of our future satellite program—proven to be a national asset after 25 years of use. Reserving a fraction of space on all environmental satellites for research experiments is suggested as well as close collaboration and joint funding by NASA. A National Space Grant (S. 2098) should be considered.

NOAA should be commended for its innovative ideas to bring its satellite program into the 1990's. At this critical time of innovation and change in key national programs, budget cuts are not appropriate.

NOAA should maintain two polar orbiters and consider convergence of both the polar and geostationary satellite programs. NOAA's direct readout/broadcast of data should be expanded even further to provide more efficient data sets to the academic community for teaching, research and training of users.

Senator GORTON. Thank you very much, doctor.

Mr. McCandless.

Mr. McCandless. Thank you.

I am here today on behalf of the National Ocean Industries Association [NOIA]. The National Ocean Industries Association is a trade organization that represents over 450 companies engaged in marine resource evaluation and commerce. We have an applications interest in space in three basic areas: navigation, telecommunications, and ocean sensing. I will concentrate on ocean sensing today.

I made three basic points in the testimony. The first point was that, although the United States pioneered ocean sensing from space, we have failed to take advantage of these discoveries during the last decade. Instead of initiating programs helpful to ocean sensing, we have delayed them. Others have picked up the charter and have moved.

In some cases, we even propose to eliminate programs that were very useful for ocean industries, such as the second NOAA polar orbiter, and I will say a word or two about that.

NOIA had a board of directors meeting last week, recommending that the second polar orbiter continue. As you know, there has been a continuing 4-year effort by OMB to eliminate the second polar orbiter, but wiser Members of Congress have held the line on that. We believe that you should continue to hold the line.

I won't repeat our full resolution here, but in summary, we object to the budgetary proposal to eliminate the second polar orbiter.

There are many reasons for that, but one of the specific ones is highlighted in both the ENVIROSAT 2000 report, which is issued by NOAA, which hasn't been mentioned here, as well as the GAO report that Dr. VonderHaar just mentioned.

Both of those reports address the risks involved of a single-polar orbiter failing and plunging us into a situation where our weather forecasting would return to the kinds of skill levels that we had in the 1940s. That would have serious consequences in many areas, including some of the ones that have been discussed today.

My second point addresses the changing situation regarding space-based collection of oceanic and polar region data in the 1990's.

In spite of the delay in establishing space-based operational remote sensing systems to concentrate specifically on ocean sensing, this situation is changing, beginning in 1990.

Beginning in 1990, we are going to be faced with an avalanche of oceans and polar region remote sensing data. Much of this data is not our data; it's a result of large investments in programs like this in Japan, in Europe, and in Canada.

Beginning in 1990, there will be satellites such as the ERS-1, which is a satellite very similar to Seasat; that satellite will be launched by the European Space Agency providing oceans and Arctic coverage.

The Canadians are considering a program called RADARSAT; they have invested considerable resource in that program, although it is not fully funded at this time. That program would also come along with high-resolution sensors capable of providing very useful data in the oceans and the Arctic.

The Japanese have two programs: One they will launch very soon called the Marine Observation Satellite; they are going to follow that launch with a program very similar to the European ERS-I and the RADARSAT programs; it will have a synthetic aperture radar on it. That program is called JERS-I.

Finally, we have our own program; we are concerned about that program—the program is called NROSS; it is a U.S. Navy program. It is very similar to Seasat, although it does not have a synthetic aperture radar on it. We have recently sent a letter to Secretary Lehman in support of the program, but also expressing concern because of the vulnerability of the program if it experiences further delays: vulnerability of budget and vulnerability of time.

We support the NROSS program very strongly.

Our basic concern is that although we are seeing an avalanche of data coming at us, we don't see that the systems and facilities are being established to take advantage of this data set. It includes not only systems and facilities, but it will include agreements with foreign governments to gain access to that data.

Finally, the third point is that even if the proper facilities are established to assimilate useful ocean and Arctic information in the Government systems, the transition from the government to the civil sector is not always effective. Issues such as civil use charges and shared costs are discussed, but many times they do not focus into working systems.

Much improvement, I think, is needed in these areas to make sure the civil sector can gain access to the data sets. For example, DOD has several environmental satellite programs which produce data of great value to the private sector in addition to the NROSS system coming up. The systems on the DMSP, particularly one which will provide very useful arctic data, are data sets that we would like to gain access to.

DOD lacks a specific mission to support the private sector and NOAA has acted in the capacity of enabling the civil sector to gain access to this data.

But the coordinating apparatus in many cases is a little clumsy in this area.

Those are the major points that we would like to emphasize. We appreciate the opportunity to brief the subcommittee today.

[The statement follows:]

STATEMENT OF SAMUEL W. MCCANDLESS, JR., PRESIDENT, USER SYSTEMS INC., ON BEHALF OF THE NATIONAL OCEAN INDUSTRIES ASSOCIATION

The National Ocean Industries Association (NOIA) is the principal Trade Association for the industries engaged in ocean resource development. Many of our 450 corporate members are active in NOIA's Telecommunications Policy Committee which has focused on space applications which support maritime operations. NOIA is the foremost advocate for operational users of maritime satellite applications, including navigation, communications, and remote sensing. In a very real sense, our efforts are on behalf of the entire civil maritime community and not solely for the benefit of NOIA members.

Space applications issues of interest to NOIA members fall into three general categories: Ocean Sensing, Navigation, and Communications. My testimony is directed at Ocean Sensing issues.

I will concentrate on three basic points in my testimony:

1. Although the United States has pioneered ocean remote sensing from space, we have failed to take advantage of our discoveries. Instead of initiating programs helpful to ocean data users, we have delayed them, and, in some cases, propose to cancel useful systems such as the second NOAA orbiter.

2. In spite of our delay in establishing operational space-based ocean remote sensing systems, other countries are proceeding. As a result, an avalanche of ocean and Arctic data will arrive at the end of this decade. The United States is making plans to collect and use some of this data, but my colleagues in NOIA are concerned about our ability to take full advantage of these new systems. We need to establish new facilities and systems to handle this data as well as firm agreements with foreign governments and institutions, allowing us to gain access to useful data sets.

3. Even if the proper facilities are established to assimilate useful ocean and Arctic information into government systems, the transaction from the government to the civil sector is not always effective. Issues such as civil use charges and shared cost are discussed but do not focus into working systems and agreements. Much improvement is needed in these areas.

I will address these issues in sequence.

THE UNITED STATES OCEAN SENSING INITIATIVE

As a general consideration, NOIA members perceive a crying need for a definitive national plan for space applications programs. The government policy-making apparatus is in disarray, particularly with respect to ocean space applications. The budget process seems incapable of producing an integrated civil-military program or an appropriate balance between research and applications. Space research and applications are inherently multiyear operations which cannot achieve maximum effectiveness if weighed in the year-at-a-time budget process. The national interest demands development of a national plan which integrates these widely varying requirements in light of budgetary realities.

NOIA members are aware that ocean sensing technology has progressed to the point where comprehensive satellite data could enable a quantum improvement in ocean weather forecasting which in turn would be a major benefit to offshore operations and safety.

Despite the demonstration of this technology by SEASAT in the late 1970's, the ocean community is still waiting for a viable operational system. We attribute this deficiency to an ineffective policy making apparatus in government. Ocean related space applications have lagged behind other applications, partly because the ocean constituency and its government advocates have not been as vocal or as effective as those of other sectors. NOIA members are also concerned about an imbalance between technology development and applications programs in national resource allocations. Our present budget for civil space programs provides less than 4% for applications programs of direct benefit to the taxpayers in terms of public safety and increased productivity of U.S. industries. The European and Japanese civil space programs are, by comparison, dedicating roughly one third of their space budgets to applications programs of direct benefit to their industries. In terms of real dollars, the Japanese and the European programs are funded three times more than the present United States applications programs. NOIA members feel strongly that a more appropriate balance needs to be established.

This year, the Office of Management and Budget (OMB) and the Administration are again attempting to reduce the number of operational polar orbit satellites from two to one. This has been a continuing effort by OMB over the past four years and, fortunately, has been defeated by wiser members of Congress.

The issue here is not one of saving money over the long term but one of committing to a high risk program for a short term savings. A NOAA study, ENVIRONSAT 2000, pointed out that over a ten-year period no savings are achieved by reducing to a single polar weather satellite; with a single satellite, a replacement must be launched at the end of each satellite's design life. In the case of a two-satellite system replacement launches may reasonably be delayed until one actually fails.

In addition, the United States General Accounting Office (GAO) recently issued a report to the Chairman, Subcommittee on Natural Resources, Agriculture Research, and Environment, Committee on Science and Technology, House of Representatives. The report assessed user views on the consequences of eliminating a civilian polar orbiter. The report found that the polar orbiters are used by NOAA for weather forecasting, search and rescue operations, and other purposes; by NASA for climate research; by the Department of Defense (DOD) as a supplement and backup to its own weather satellites; and by countries worldwide for weather forecasting and environmental data collection. Users in NOAA and DOD reported that the elimination of one of NOAA's polar-orbiting weather satellites would harm their programs, but most users indicated that they could continue their programs with one satellite. All users, however, said that the second satellite was important as a backup to the first and that the loss of all service would have serious consequences. The NOAA geostationary satellites and DOD's weather satellites do not adequately replace NOAA's polar orbiters, according to most users. In the past, some of NOAA's polar-orbiting satellites have not been successfully launched, or their launches have been delayed, and some have failed early in orbit. A repetition of these problems in a one-satellite system could result in a loss of all services for several months or longer. According to NOAA documents, the loss of all NOAA polar orbiter coverage would be immediate and disastrous on National Weather Service products. For example, forecasts for the oceans in the southern and northern hemispheres for even short periods in advance—a day or so—would be seriously degraded; the accuracy of medium-range forecasts—3-10 days over much of the United States—would be diminished to the point where weather forecasts beyond 5 days might not be of any value.

The differences between the military and civilian polar-orbiting weather satellite systems are that the primary DOD requirement is for imagery, while the primary civilian requirement is for vertical temperature profiles. Because of these differing primary requirements, some differences exist in the sensors flown on the civilian and military satellites.

Although both the military and the civilian systems orbit their spacecraft at about the same altitude, differences also exist in their orbit times. The DMSP equator-crossing times are currently both in the morning. The NOAA equatorial crossing times are fixed at 7:30 a.m. and 2:30 p.m. the DMSP times were selected to meet specific military needs. The NOAA orbits were chosen to provide timely inputs to numerical weather prediction models but are also advantageous to some military users. The recent shuttle tragedy has shown us that unanticipated failures can and do occur in the space programs. For this reason, reliability of this vital weather satellite program must not be reduced to a high risk single satellite system because a failure would result in revision of the ocean weather data coverage to a level that existed prior to the 1940's.

NOIA members have been concerned with the state-of-the-art in marine weather forecasting, especially in light of the severe storm damage our industry sustained during the last hurricane season. In fact, our Telecommunications Policy Committee (TPC) has recently launched an extended review of Marine Weather Technology. While it is too early to have arrived at any conclusions, it is clear that any move to reduce the polar weather satellite program would be very detrimental to the quality of marine forecasting.

THE COMING AVALANCHE OF OCEAN AND ARCTIC DATA

Beginning in 1987, a large number of foreign and domestic operational marine remote sensing systems will be placed in space. This planned capability represents a $1.5 billion investment in systems that will usher in an important era of capabilities. The impact will be similar to the extension of communications industries in space. The major question is going to be, "Is the United States prepared to take advantage of this opportunity?"

At present, space-based oceanic data is limited to standard meteorological data over the seas provided by both the polar-orbiting and geostationary civil, and, to a lesser extent, military weather satellites. Added to these measurements are ocean color data products from the experimental NASA Nimus-7 satellite, which continues to operate in 1985 long after its two-year mission began in 1978. These satellites provide limited, but valuable, marine information.

Sea ice and sea surface temperature (SST) maps are also produced by the Advanced Very High Resolution Radiometer (AVHRR) carried by the NOAA polar orbiters. The AVHRR data, along with ship and buoy data, are used to produce a wide variety of SST products (East Coast, West Coast, hemispheric, synoptic, anomaly, etc.). Ocean Feature Analysis (OFA) products (Gulf Stream, Gulf Loop Current, cyclonic and aniticylonic eddies, coastal upwellings, etc.), and ice analyses (Bering Sea, North Slope, Great Lakes, etc.). The polar-orbiting and geostationary satellites also provide for in-situ environmental data collection from buoys, ships, and offshore platforms.

The Nimbus-7 Coastal Zone Color Scanner (CZCS) measures color with sufficient precision to map the distribution of marine phytoplankton. The biological productivity of the ocean can be estimated as well as products related to water clarity. Interestingly, marine phytoplankton is also useful as a tracer in the study of mesoscale ocean dynamics. There is no planned replacement for the CZCS which is currently at the end of its useful life.

The above products are widely used, but they are not adequate to meet all the needs of the maritime community. The immediate problem with the satellite-derived products is that they are based on sensors that operate in the visible and infrared portion of the spectrum, which are limited by cloud cover and lighting conditions (darkness). A further problem is that the current systems do not measure other major ocean parameters, such as wind and sea state.

Significantly more ocean parameters can be obtained from satellite measurements. The marine community requires all-weather, all-season data, such as that pioneered by the United States with the experimental SEASAT Satellite. The evidence produced by SEASAT and other proof-of-concept ocean sensing systems, such as Nimbus and GEOS-3, was sufficiently convincing that large ocean and Arctic remote sensing programs were initiated by foreign governments.

The availability of ocean and polar region data begins a steep upward course near the end of the decade when several important foreign and domestic programs place systems in space.

1. ERS-1. The operational successor to the SEASAT mission is being sponsored by the Euopean Space Agency. Although the specific sensor design is different, the basic instrument complement is nearly identical to the SEASAT design. This mission is in a hardware development phase and will begin to return data from space in 1989/90.

2. RADARSAT. This mission will use a radar imager and other sensors to monitor the Arctic several times a day in all weather conditions. Near-real-time distribution of data to commercial users is a program objective. The mission was conceived in Canada and is being supported by the U.K. and the European Space Agency. System development is in progress with a launch planned in the early 1990's.

3. MOS-1. The first Japanese entry into space-based ocean sensing is a modest mission using optical and passive microwave sensors. However, it represents the first of a series of similar missions that will be progressively more valuable. The first MOS mission is scheduled for 1986, with a second launch in 1990. The second mission will include active radar sensors.

4. JERS-1. Following MOS-1 the Japanese plan to launch a Synthetic Aperture Radar (SAR) imager, with some associated sensors, in the 1990's time period. This system will be capable of producing all weather high resolution images of ocean and polar regions.

5. NROSS. The U.S. Navy plans a 1990 launch of the Navy Remote Ocean Sensing System (NROSS) satellite, which again builds on the SEASAT/Nimbus-7 heritage. The payload includes a SEASAT-type radar altimeter, an improved (six-antenna) scatterometer provided by NASA, the previously mentioned DMSP multi-frequency microwave imaging radiometer (SSM/I), and lower frequency microwave radiometer used to provide all weather sea surface temperature. All weather observations of sea surface wind velocity, wave height, temperature, sea-ice concentrations, and location of oceanic fronts and eddies will provide tactical Naval support and will be used in the Navy's operational forecasts. At present, this program is in the Request for Proposal (RFP) stage.

6. TOPEX. NASA's Ocean Topography Experiment (TOPEX) satellite is proposed for an early 1989 launch into a 1300 kilometer (806 mile) orbit, with an inclination near 65 degrees. It will carry a very precise radar altimeter and orbit determination packages so that the surface topography of the ocean can be measured to an accuracy of 14 centimeters (5.5 inches) or less across an entire ocean basin. TOPEX data will provide an opportunity to significantly increase our understanding of large

scale oceanic circulation, and augment the planned World Ocean Circulation Experiment. This program expects to issue an RFP sometime this summer.

7. NOAA/TIROS. A continuing series of NOAA polar-orbiting meteorological satellites is approved for launch during the latter half of the 1980's. In addition to a variety of atmospheric sounders such as the High-Resolution Infrared Radiation Sounder (HIRS), the satellites carry the AVHRR used for infrared sea surface temperature measurements accurate to 1°C (1.8°F) with 1 kilometer (0.62 mile) resolution; the French ARGOS positioning and data relay system; and the International Search and Rescue emergency beacon system. At present, this system is under stress from OMB to reduce the two-satellite system to a single satellite.

As you can see, the burgeoning interest in ocean and polar region remote sensing from space will produce a deluge of new data near the end of the decade. The real challenge will be the complex negotiations that must take place between various U.S. civil and military government programs and, also, with other governments. U.S. marine data users will not gain access to new data unless their needs are known and fairly protected during negotiations and unless these negotiations are successful. In concert with these negotiations, new systems must be established to collect, convert and distribute this new data.

COMMUNICATION AND DATA TRANSFER BETWEEN THE GOVERNMENT AND CIVIL SECTOR

DOD has several environmental satellite programs which produce data of great value to the private sector. These data have traditionally been made available, typically through NOAA which has a mission to support the private sector. NOIA members have become concerned in recent years that NOAA had been unable to get budgetary support for the relatively modest expense of handling the dissemination role. Since DOD lacks a specific mission to support the private sector, the public could be denied access to valuable data products acquired at public expenses. The national interest demands a resolution of this problem. It does not make sense to make a large investment in data acquisition and fail to follow through with product dissemination to the public. The government coordinating apparatus is very clumsy in this area, however. As an example, OMB officials have denied NOAA coordinated participation in DOD programs and, in forcing DOD to absorb the extra cost, have failed to achieve the national cost savings which the cooperative program would have enabled.

Congress has clearly shown its intent by providing NASA the civil space technology development charter and NOAA and civil space applications charter. They certainly recognize the need for a balance between these two vital civil space activities. However, the present administration through the Office of Management and Budget (OMB), has consistently refused adequate budget support for this new NOAA mission. This inaction has resulted in a defacto United States space policy that is directed solely to the development of technology with no clear intent of applying that technology for the benefit of the tax payer who is footing the bill. It is the policy that must be changed.

There are examples of useful data sets that may be difficult to obtain. In 1985 an important addition was made to ocean data sources. The Navy Geosat satellite with its radar altimeter was launched in March 1985. The special sensor microwave imager (SSM/I) will be added in 1986 to the Defense Meteorological Satellite Program (DMSP) satellites.

Satellite radar altimeters have been flown on Skylab, GEOS-3, and SEASAT. From these data, sea surface topography, wind, ice edge, the marine geoid, and significant ocean wave height (mean height of the highest one-third of the waves in a long data record) can be derived. Using this system, the maritime community will be able to obtain a global grid of significant wave heights.

The SSM/I is an extension of work begun with the Nimbus-7 and SEASAT using the Scanning Multichannel Microwave Radiometer (SMMR). The SSM/I measures wind speed, precipitation, sea and polar ice extent and age, and cloud water vapor content. In 1986, the civil maritime community could have access to global wind speed data with a grid spacing of up to 25 km about every 36 h. The polar region ice fields will be updated every 24 h with a spatial resolution of 25 km.

Thus, when these data are combined with those of Geosat, the civil maritime community could have global data fields of significant wave height and surface wind speed on a routine basis. At present, it is not clear just how this data will be made available to civil users.

Ocean sensing experiments and applications in general require massive logistic coordination of near-real time data. The key need is mechanisms to facilitate end user access to data in near-real time for data integration and decision processes. Data access is the key to stimulating this capability.

NOIA ACTIONS AND RECOMMENDATIONS

ACCESS TO DATA—The primary interest of the NOIA Oceans/Sensing Subcommittee is to improve the availability of existing and forthcoming satellite data to the maritime and offshore industry.

GEOSAT—Derived Altimetric data; i.e., wave height, wind speed, and, if possible, dynamic height.

SSM/I—Digital images (derived data on wind and ice properties, if available).

NROSS—Derived data from all sensors; i.e., wave height, wind speed and direction, precipitation, and sea surface temperatures.

ERS-1—SAR images and derived data from other sensors.

JETS-1—SAR images and derived data from other sensors.

RADASAT—SAR images and derived data from other sensors.

Two data formats are required:

1. Near real-time for specified locations for operational needs.
2. Archival data sets for applied research and climatological analyses.

NOIA recommends that NOAA study the means and costs for providing near-real time access to certain satellite-derived data as enumerated below. If NOAA does not think the present Administration would absorb these costs and were to propose user charges, the data are of sufficient value that these costs might be recovered via user charges.

The data volume from the Geosat altimeter, the DMSP SSM/I radiometer and the instrument complex on the NROSS will be very large, requiring expanded data access and processing systems not operationally in place at present. NOAA plans to access and use these data for government functions via a system called shared processing, which will link the Air Force (Offut), the Navy (Monterey), and NOAA/NESDIS (Washington, D.C.). Thus, NOAA is the appropriate entity to provide access to these data for the ocean user community.

Satellite remote sensing of the ocean will evolve in much the same manner that satellite meteorology has progressed. It is also inevitable that the civil maritime community will find the data essential to business as marine applications become increasingly sophisticated and more and more sensitive to environmental perturbations. Marine businesses having a ready access to such data will survive and prosper. Nations with limited access to such data are not likely to keep up in the area of marine commerce.

SEVERE STORMS—NOIA has recently undertaken efforts to get the National Reserch Council to undertake a "Study of Maritime Storm Warnings." We believe a study would be most timely, particularly so in light of NOAA's move to eliminate its Ocean Service Program.

The study will address the following issues:

1. The basic requirements of the U.S. maritime industry for storm predictions and warnings.
2. The current capabilities of the National Weather Service, other federal agencies, private organizations, and foreign governments to meet these needs.
3. The approximate magnitude of potentially avoidable storm damage to U.S. maritime activities.
4. Specific steps that can be recommended to the federal government, private environmental service organizations, and maritime operators to improve the effectiveness of maritime storm warnings.

SUPPORT FOR THE NAVY NROSS PROGRAM—NOIA has been a staunch supporter of NROSS which would provide much of the SEASAT technology. NROSS does not have a synthetic aperture radar sensor as do ERS-1, JERS-1 and RADARSAT. NROSS has been sponsored by DOD because of its direct and significant military applications. Civil users have been promised access to most of the data relating to surface weather and sea state. NROSS is a real national asset of direct benefit to both the public and private sectors even though issues relating to private sector data dissemination have yet to be resolved.

NOIA recently sent a letter to Navy Secretary Lehman to express NOIA's strong support of NROSS. We expressed concern regarding the Navy NROSS projects rather slow progress in implementing this very beneficial program. The current budget pressures are expected to escalate next year and NROSS could be vulnerable if significant progress toward deployment has not been made. The pressures on the FY 87 Budget and POM 88 (FY 88-92) will only accommodate those programs with solid requirements and efficient execution.

NOIA members enthusiastically support the NROSS program and urge your strong support as well. We further urge your continuing review of the NROSS program as it moves from its present system contractor selection phase into final system design and fabrication. We strongly urge retention of the currently planned sensor complement. The early 1990's launch schedule is also extremely important to establish a United States program in light of the foreign programs already in place.

REDUCTION OF THE NOAA POLAR ORBITERS—The NOIA Board of Directors recently adopted a resolution relative to weather satellites during its 6 April 1986 meeeting in Washington, D.C. The full resolution is being communicated to members of Congres and will not be repeated here. In summary, the NOIA Board of Directors strongly objects to the budgetary proposal to reduce NOAA's TIROS Program to a single satellite and urges the Congress and the Administration to take the necessary action to preserve the integrity of this program which is vital to the safe operation of the offshore industries and, indeed, the entire maritime community.

CONCLUSION

NOIA appreciates the opportunity to brief the Subcommittee on Science. Technology, and Space. We are mindful of the broad scope of your review and we recognize that it may be impossible to treat individual space missions in any detail, but we feel that the issues raised by NOIA should be addressed for your considerations. Specifically, NOIA has called for a national plan which lays out a balanced progam of research and applications and a commitment to ocean satellite programs which can make major contributions to the safety of life and property at sea. NOIA feels that a national plan is also needed to maximize the effectiveness of our limited budgetary resources and to resolve ambiguities in Agency roles. We can ill afford to dissipate the vast potential of our world leadership in space technology through an inability to cope with national management imperatives.

Senator GORTON. Thank you very much, Mr. McCandless, and, by the way, your written statement will be included in the record.

In that statement you mentioned some ocean remote sensing data are of sufficient value that user charges may be appropriate.

Can you go beyond that? Do you believe that the maritime community could support a commercial ocean remote sensing system?

Mr. MCCANDLESS. I do not think that the maritime community or other communities that find weather data or ocean data useful have the capacity—and I do not make that statement in terms of the resource capacity in dollars, but essentially the cohesive capability to produce such a system and fly it on their accord.

However, I do believe that there is enough interest in those systems that either government systems or commercial systems could levy a charge for the data itself. There is evidence of that already. There are instances where we, in fact, pay for data coming from various locations now.

We use private systems to assimilate the weather data and prepare it in formats and in areas useful to our interests.

Senator GORTON. You stated, both in writing and orally, that the United States has failed to take advantage of its discoveries and ocean remote sensing. What role do you believe NOAA should play in the collection and management of the oceanic data which will be generated in the coming years both by our systems and by foreign systems, and how much additional funding would be required to implement those recommendations?

Mr. McCandless. That is a large question. Let me start right from the top.

I might be excused for being a little biased in this area; I was the program manager at NASA for Seasat.

But my own very strtong belief is that we failed to take advantage of Seasat, that NASA, NOAA—whoever—should have established an ocean remote sensing program more quickly in the last decade. It would have been very useful; I see our foreign neighbors taking advantage of those lessons—those sensors that we developed, those discoveries that we made and moving forward with them before we did.

So I am distressed, still, to find we are on the back part of the power curve at this point instead of on the front part, where we belong.

Now relative to the second question: I believe that NOAA has done a good job in many areas, but they are underfunded particularly in this one and that they need to have a firm charter to establish access to the foreign data sets as well as the NROSS system coming up.

And I think that that requires a strong initiative within NOAA today to begin to put systems in place to do that job. But I also believe they need budget support to do that, stronger than they have today.

Senator Gorton. Perhaps you cannot go any further than that. But do you have any idea how much stronger—how much more?

Mr. McCandless. Well, basically, to assimilate the foreign ground systems data, what you need are collection systems—for instance, NASA is establishing an Alaskan collection station at the University of Alaska to collect information from the European ERS I satellite system.

That data will be available to NOAA; NOAA needs to specifically improve their link between Alaska and Suitland, so that the high-data rate systems can get data to Suitland quickly and the data can be used in areas like the Joint Ice Center—that's a specific one—the data would be available to the civilian community as well as the government.

That is a specific example. Now those systems are not in place today; there has been some work done in getting ready for them, but I do not think it is adequate. We are talking about tens of millions of dollars, not hundreds of millions of dollars in this case, I think.

Senator Gorton. I believe that both of you were here through the entire morning and heard statements about the management of NOAA's polar orbiting satellite systems under a one satellite configuration.

Do either of you believe that NOAA could realize the level of savings which it estimates in its 1987 budget submission or do you think that management changes would erode those savings suggested in the ENVIROSAT 2000 study?

Dr. VonderHaar. Well, in terms of the savings, Senator, I am just not an expert in that area. I saw their budget numbers and I thought they amounted to something like $29 million.

Is that correct? Savings to go to a one satellite system and not being an expert in budget matters, I would believe that the technical arrangements that would have to be made and the adjustments that would have to be made throughout all the user communities would certainly eat into some of that.

Senator GORTON. Mr. McCandless.

Mr. McCANDLESS. Well, I de-cry the whole budgetary process attacking these kinds of programs right now. Fundamentally, I think these are core programs that affect a broad populus, both the weather satellite systems and these upcoming ocean sensing systems are going to be key to Commerce, Science, in the areas that we cannot even forecast today.

I think it is really a false economy to continue down this path.

Senator GORTON. Dr. VonderHaar, which satellites should carry research experiments and which specific shortcomings do you see in the Administration's commitment to atmospheric research?

Dr. VONDERHAAR. Certainly. NASA's observation program carries research satellites, and they have put up some recently that address the climate problem and they have plans to put up some more.

However, the demise or the natural end of the NIMBUS program, which carried a lot of research experiments for both meteorology and oceanography has left a gap in our situation here.

The Administration has not addressed that problem head on, in my opinion. Thus I believe that we should cover that gap by adding, wherever possible, on a non-interference basis on the operational satellites both the polar orbiting and the GEO stationary, selected experiments that have been well tested out by the scientific community conceptually and that will ultimately help the missions of both—of NOAA, for sure, and probably the Department of Defense.

So I am proposing that that be considered in your planning.

Senator GORTON. If I could, as a final question, I would like both of you to comment on the appropriate role of the government in developing applications for satellite data. Should we spend more money on applications or should we concentrate on building systems and leave the applications to the private sector and to universities.

Mr. McCANDLESS. I'll go first.

We have been concerned about an imbalance between technology development and applications programs for some time. For example, if you take a look at our budget right now for civil space application, we spent less than about 4 percent of the space budgets for applications programs.

Now without commenting on whether that is enough or not, let me refer you to the part of my testimony where I discussed a result of what is happening in foreign areas.

Let me just point out to you that in Japan and Europe, they are spending approximately one third of their space budgets on applications programs. I think that the fact that they are coming along now with real systems that are going to be in place in 1990, that will be providing data, is a result of their applications investments.

And we cannot kid ourselves; even if we have a memorandum of understanding with Canada and the European Space Agency and perhaps even Japan—their sovereign interest is going to direct the bulk of that data into their own economies.

So I would say that you are looking at the result of a much lower expenditure in the applications area in the United States versus the size of the applications expenditure in other places.

Dr. VONDERHAAR. Well, I think if we look at the 25-year history here, we have some good evidence that applications that were pioneered under support of the government research groups and NOAA and NASA have now found the way into—you know, everyday use: television weather forecaster's use of the geo-stationary satellite pictures as an example. Fisheries use of the ocean data is another example.

But I agree with Walt that it takes a concerted effort in applications research sponsored by the government to bring those kind of things to the floor and then they are picked up by business, by the general populus, et cetera.

So I think we have to continue our applications research program and——

Senator GORTON. If anything increases, I take it?

Dr. VONDERHAAR. Well, I do not again—I do not know the numbers as well as Walt does. But at this time I know that NOAA's applications program—there are scientists within NOAA and NESBUS who are full-time working on transfering this technology and these results into these kind of applications. And they certainly should not be decreased.

Mr. MCCANDLESS. Could I add one final comment, if possible?

Senator GORTON. Certainly.

Mr. MCCANDLESS. My experience has been that the research community represented by Dr. VonderHaar and the applications community which I think I represent or have, are really very close together; we depend on the research community.

In the business areas, the kind of innovative discoveries of sensor design and what you can do with the data and how, in fact, you can convert voltages and currents, if you will, to useful geophysical information really comes out of that community.

That is the payoff of the research and applications budget. It is a transition affect; you have to consider the research activities and the applications activities together and in many cases some of the same people are involved and should be. There should be a tight link between the two groups.

Senator GORTON. Thank you.

Thank you, both, very much. Thank you for your enlightening testimony.

We stand adjourned.

[Whereupon, at 11:50 a.m. the subcommittee was adjourned, subject to the call of the Chair.]

[The following information was subsequently received for the record:]

STATEMENT OF STANLEY A. CHANGNON, PRINCIPAL SCIENTIST, ILLINOIS STATE WATER SURVEY; R. LYNN ROSE, DIRECTOR, NORTH DAKOTA WEATHER MODIFICATION PROGRAM; PAUL SUMMERS, ASSISTANT DIRECTOR, UTAH DIVISION OF WATER RESOURCES; JOSEPH WARBURTON, EXECUTIVE DIRECTOR, ATMOSPHERIC SCIENCES CENTER, DESERT RESEARCH INSTITUTE, RENO, NV

NOAA FEDERAL/STATE COOPERATIVE WEATHER MODIFICATION RESEARCH

The nation's efforts to develop weather modification capabilities to protect lives and property and to enhance water supplies, agricultural production, and transportation have largely been a federal responsibility since the discovery shortly after World War II of means to modify certain types of fogs and clouds. Congress (PL83-256) established in 1953 an Advisory Committee on Weather Control, and its 1957 report to President Eisenhower and the Congress stated that weather modification capabilities were in the national interest (a theme that all succeeding major assessments agreed with), and that NSF should establish a weather modification research program (effectively also acting as a lead agency). This recommendation was followed (PL85-510, 1958), but later rescinded (PL90-407, 1968) when other federal agency programs had become strong, more project oriented, and more developmental than research oriented. Annual reporting of all weather modification projects (which had been done by NSF) also ended in 1968, but was resumed in 1971 (PL92-205) by NOAA in recognition of federal monitoring responsibilities.

The most recent major effort to assess and re-focus the national effort resulted from PL94-490 (1976) which directed the Secretary of Commerce to establish an external group to assess the situation. After two years, the Advisory Board recommended (1978) a re-structured focused national program with a director in a lead agency (NOAA) and a sizable budget.

One of the principal recommendations (page 14, WMAB) was to develop a federal/state cooperative program in weather modification research in order to take advantage of shared resources and scientific capabilities. In 1979 Conqress found it to be in the best interest of the Nation to immediately implement this aspect of a National Program.

To support this action, Congress first added additional funds to the NOAA FY-1979 budget for the federal/state effort. Such funding has continued through FY-86. Each year NOAA has deleted the funds. Although strong support has been received from Congressional appropriation committees, the program has not been consistently authorized. It is our belief that authorization of the program would provide the additional encouragement for NOAA to include the program in future budgets.

It is requested that the Subcommittee include in the NOAA authorization, language to provide for appropriations not to exceed $3.0 million per year for the next succeeding 5 years for the Conduct of the Federal/State Cooperative Weather Modification Research Program.

Supportive Evidence:

The four state projects that comprise the Federal/State cooperative Weather modification research program, and are funded by NOAA and the states, have over the past 3 years made very significant scientific and technological progress in defining basic physical and chemical linkages in the complex chain of weather modification. Examples of this recent progress are numerous.

Scientists at the Illinois Water Survey, working with university scientists at Purdue, Illinois, Chicago, and Wyoming, have finished 6 years of Pre-Experimental research studies (laboratory, computer and field) to conclude that a certain class of summer clouds in the midwest appears likely to respond favorably to a certain type of seeding. To this end a scientific hypothesis ha? been elucidated for field testing beginning in 1986. Since 1981 29 scientific-journal papers and 9 reports have been published reflecting the high quality of the science conducted.

Scientists working on the Utah project have used radars and other remote sensors to detect where super cooled liquid water is concentrated in winter clouds over mountains, and this allows better estimation of where and how much added snow will occur. Correlated airflow measurements have led to better determination of where and when seeding materials should be released into clouds. The scientists working on the project at 3 universities have published 12 scientific papers in the past 2 years.

In the 3 years of the Nevada program, new techniques have been developed using stable isotopes of water and ice crystal structures to locate regions of liquid water in clouds and how seeding affects them. Newly developed trace chemical techniques have identified how complex-mountainous terrain affects cloud formation and aerosol transport from the ground into winter storms and how these aerosols are transported into downwind areas across state boundaries. New airborne studies of water and ice in clouds augmented by remote sensing, provide new evidence of seedability potential for increasing water supplies in the arid west. Ten scientific publications have resulted from this work in the past two years.

North Dakota has investigated transport and dispersion in cumulus clouds, which is important to the acid rain issue and other pollution problems of the atmosphere.

The investigations have been made using the tracer gases being released at various locations in and around cumulus clouds. Monitoring the mixing within the cloud is carried out by a sophisticated cloud physics aircraft making measurements on liquid water and ice processes, which are key to summer precipitation. This research has involved staff from North Dakota State University, University of North Dakota, South Dakota School of Mines and Technology, University of Wisconsin and Oklahoma University.

The scientific and technological achievements of the four state projects are further described in NOAA (Winter 1986 issue), the agency's periodical.

In 1985, this program funded approximately $1,000,000 for the development of special new field equipment (a mobile scanning microwave radiometer, instrumented research aircraft, a 10 cm computerized Doppler radar system, a realtime mobile forecast system, and a short wave-length 8.6 mm radar system) to be shared by all four projects so as to achieve high cost effectiveness. These unique tools are now built or under construction and will be ready for their first field usage planned for 1986-87.

For example, the $0.4 million computerized Doppler radar developed in Illinois is to be used with the Nevada research aircraft with its new atmospheric sensors in 1986-1987 to study how midwestern summer clouds react internally to seeding at the -10 degree Celsius level.

$500,000 has been spent in Nevada designing and constructing a new short wavelength radar for the Utah project and a new scanning microwave radiometer for the Nevada program. These instruments will be used in the 1986-87 winter projects in these states to study seeding effects on precipitation growth and snowfall enhancement. North Dakota, working with University of Wisconsin (Madison) is developing a satellite data processing system for directing field operations and for subsequent evaluations of seeding effects.

We believe the efforts of this program are in the national interest because they collectively represent a singular coherent program in the nation's weather modification effort. Notably, all past and present scientific assessments of this field called for a major federal role in support of weather modification research. The findings in Utah about how to enhance snowfall are applicable to other mountainous regions of the west; the studies of downwind effects of seeding in California on precipitation in Nevada are fundamental and transferable to other western areas; the North Dakota studies of hail suppression and precipitation enhancement are applicable to the Great Plains; and the Illinois oriented efforts to learn if summer rain can be increased are applicable to the Midwest.

In NOAA (Winter 1986 issue) we find key comments supporting our view: "the four federal-state programs are in four different climate regions, yet address problems of both regional and national interest—Importantly, it appears what is being learned in each state can be extrapolated well beyond the state boundaries". The weather modification research is as important today as it was at the time of the Advisory Board report. The scientific productivity of this cooperative program provides evidence of the validity of the Weather Modification Advisory Board's recommendation to the Secretary of Commerce. Thank you for your consideration.

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